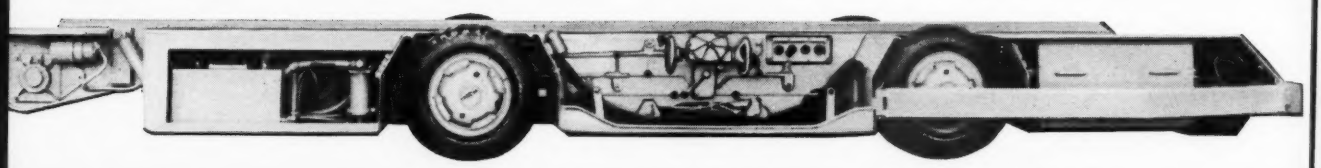
# MINING CONGRESS JOURNAL

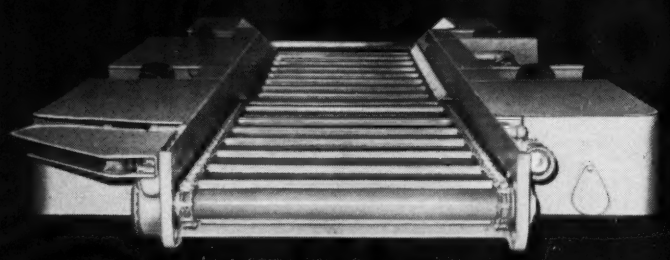
MAY 1959

# Engineered for Performance in extremely THIN seams



...the NEW

# TORKAR® TYPE 26



Boom end of Type 26 TorKar showing wide 56" conveyor

With overall body height of only 25½ inches, this latest model extends the range of TorKar performance to the thinnest commercially-workable seams . . . with every outstanding TorKar advantage retained.

Powered by a single AC or DC motor with efficient torque converter, the Type 26 TorKar has 3-speed forward and reverse transmission, 4-wheel drive, 4-wheel no fight steering, large 3½ ton capacity. For smooth operation, nimble thin-seam performance, rugged construction and long, low-maintenance life in service, *choose TorKar Type 26.* Write for specifications and prices, or call your National Mine man, today!

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# MINING CONGRESS JOURNAL

VOL. 45 MAY 1959 NO. 5





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## CONTENTS

Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

### ARTICLES



### DEPARTMENTS



### ON OUR COVER

At American Gilsonite's operation in Utah, oil-bearing rock is cut loose by high velocity water jets and then pumped to the surface. This unique mining method is described in "Mining by Hydraulic Jet," page 45.

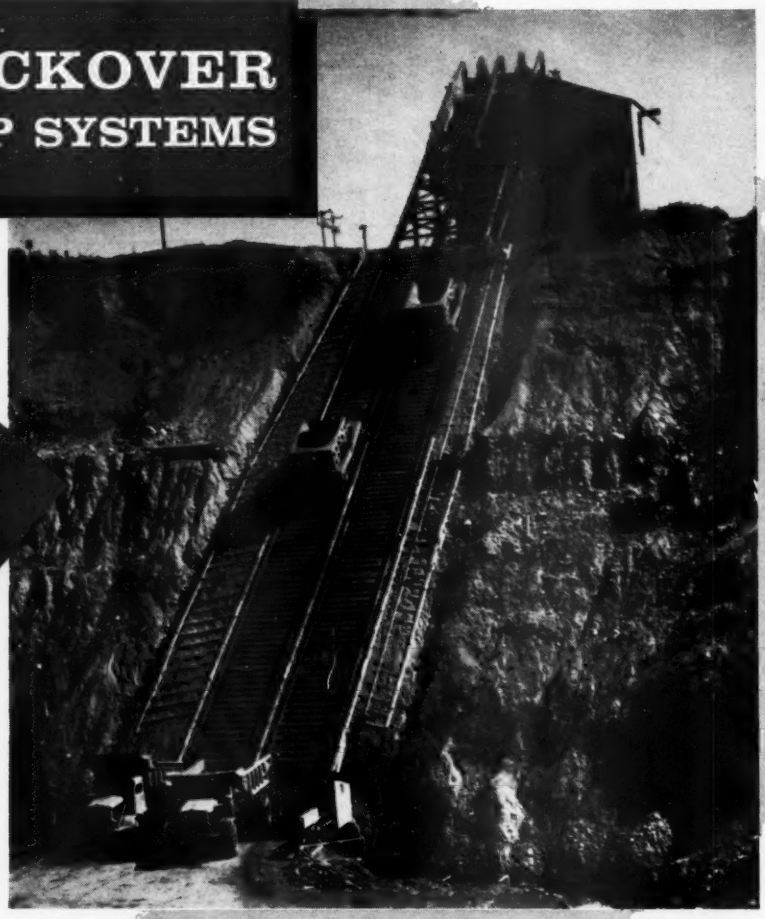


Published Monthly. Yearly subscriptions, United States, Canada, Central and South America, $3.00. Foreign, $10.00. Single copies, $0.75. February Annual Review Issue, $1.25. Second class postage paid at Washington, D. C., and at additional Post Office, Lancaster, Pennsylvania.

# *Elevate materials at* LOWEST COST PER TON

*with* **ROCKOVER SKIP SYSTEMS**

**IN USE SINCE 1949**



**The ROCKOVER SKIP SYSTEM has proven to be the most economical method to elevate materials from open pits. It uses the shortest and fastest hauling route, has the lowest operating and maintenance costs and requires no large investment in parts and standby equipment.**

**Rockover Skip Systems require no expensive wide roads for pit access and require a minimum of personnel . . . are flexible to follow pit bottom as operations go deeper . . . haul either waste or ore at anytime . . . may be loaded at any desired bench and require no sizing equipment in the pit.**

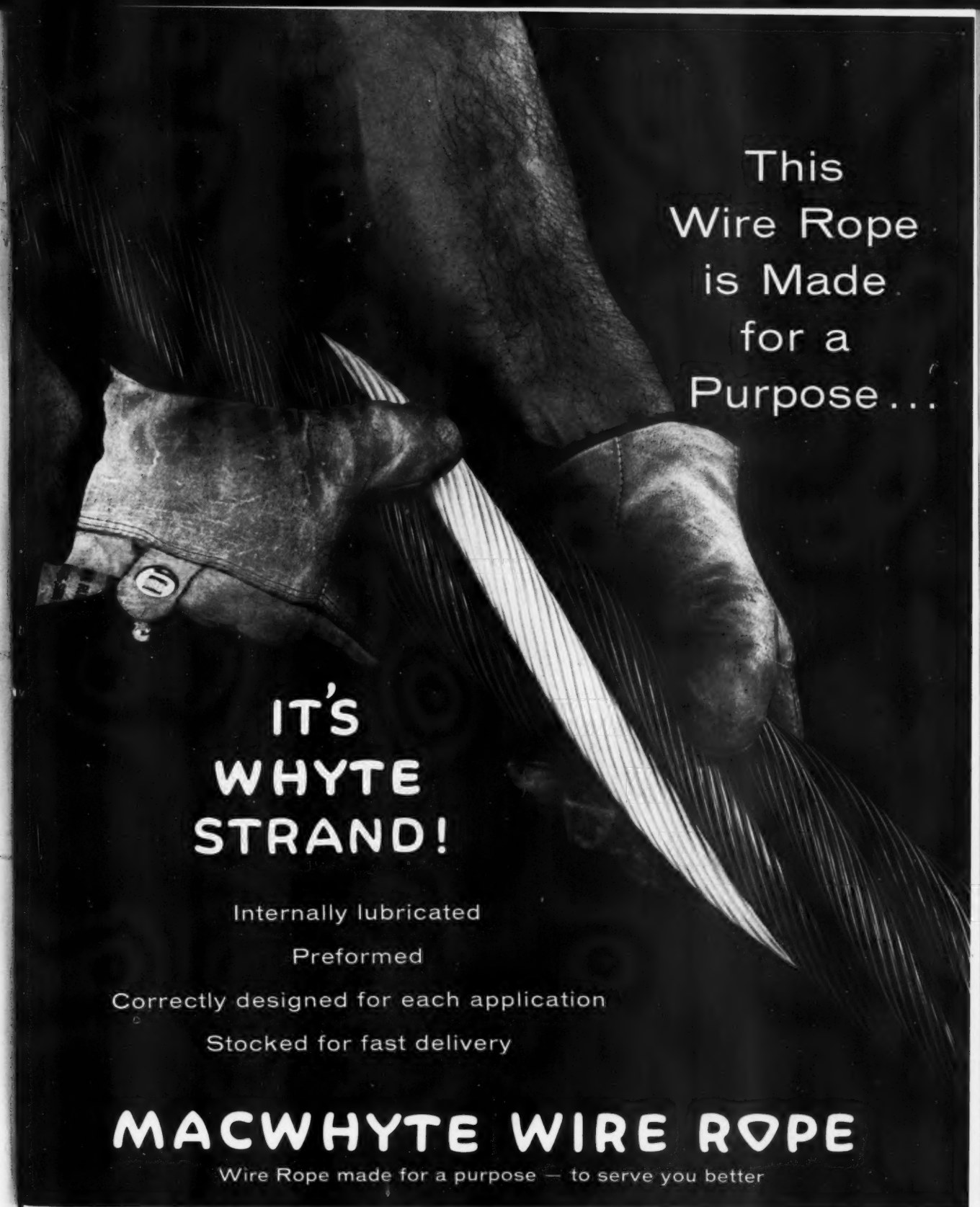
NICO SKIPS FROM 15 TO 50 TON CAPACITIES AVAILABLE

**Write for illustrated brochure.**

## NATIONAL IRON COMPANY

**50th Avenue West and Ramsey Street ● Duluth 7, Minnesota**

**Subsidiary of Pettibone Mulliken Corp., Chicago 51, Illinois**




For strip shovels, loading shovels, draglines, shaft hoists, haulage, underground scrapers, loaders, mining machines, conveyors, car pullers, blast hole drills.

161

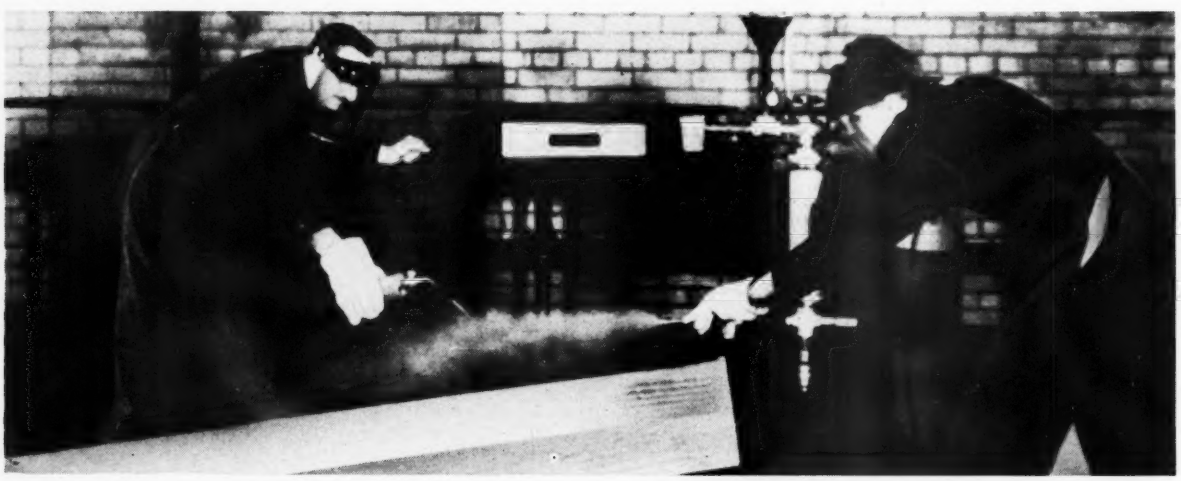
**MACWHYTE WIRE ROPE COMPANY • 2900 Fourteenth Avenue • Kenosha, Wisconsi**

Manufacturers of a thousand and one different wire ropes, slings, and cable assemblies
Distributed and stocked throughout the United States

# First low-cost

## Flame tests prove fire-resistant properties of this hydraulic oil

Dramatic photo above shows flammability of conventional hydraulic oil.



Not so dramatic, but . . . see how Shell 3XF Mine Fluid resists flame.

**Photos courtesy: U. S. Bureau of Mines**

# SHELL 3XF

# fire-resistant mine fluid

## Shell 3XF Mine Fluid has been tested by U. S. Bureau of Mines and is now in use

Now—for the first time in mining history—an inexpensive, fire-resistant emulsion-type hydraulic fluid is available for mine equipment use—Shell 3XF Mine Fluid.

**NO MAJOR MODIFICATION OF EQUIPMENT IS NECESSARY**—Shell 3XF* is a direct replacement for ordinary hydraulic oils now in service.

**CONVENIENT TO USE**—Shell 3XF Mine Fluid, furnished as a concentrate, is mixed with water to prepare the emulsion *at the mine location.*

**PROOF OF ITS FIRE-RESISTANT QUALITIES**—In addition to recommending the use of fire-resistant hydraulic fluids in mining machinery, the Bureau of Mines has evaluated Shell 3XF Mine Fluid using test methods that determine fire-resistant properties, and accepted it for Mine evaluation, pending the establishment of a Bureau approval schedule.

---

**FOR COMPLETE INFORMATION** on Shell 3XF Mine Fluid, write or call Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California. In Canada: Shell Oil Company of Canada, Limited, 505 University Avenue, Toronto 2, Ontario.

*Trademark

# MINE FLUID

SHELL


# The Standard of Comparison for UNIFORMITY

The alloying, forging and heat treating techniques used by Sheffield assure uniform quality. Fine, dense grain structure and the proved combination of hardness and toughness extend to the very core of a Moly-Cop ball. That's why Moly-Cops retain their spherical shape longer, save charging and down-time, and give you a better, longer grind at lowest cost per ton.

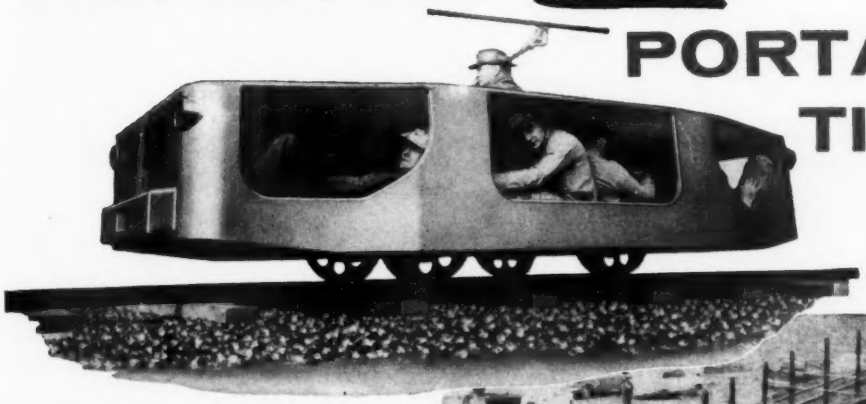
New steels are born at Armco

## SHEFFIELD DIVISION

ARMCO STEEL CORPORATION

OTHER DIVISIONS AND SUBSIDIARIES: Armco Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

# You, too, can *reduce* PORTAL TIME *up to 50%!*

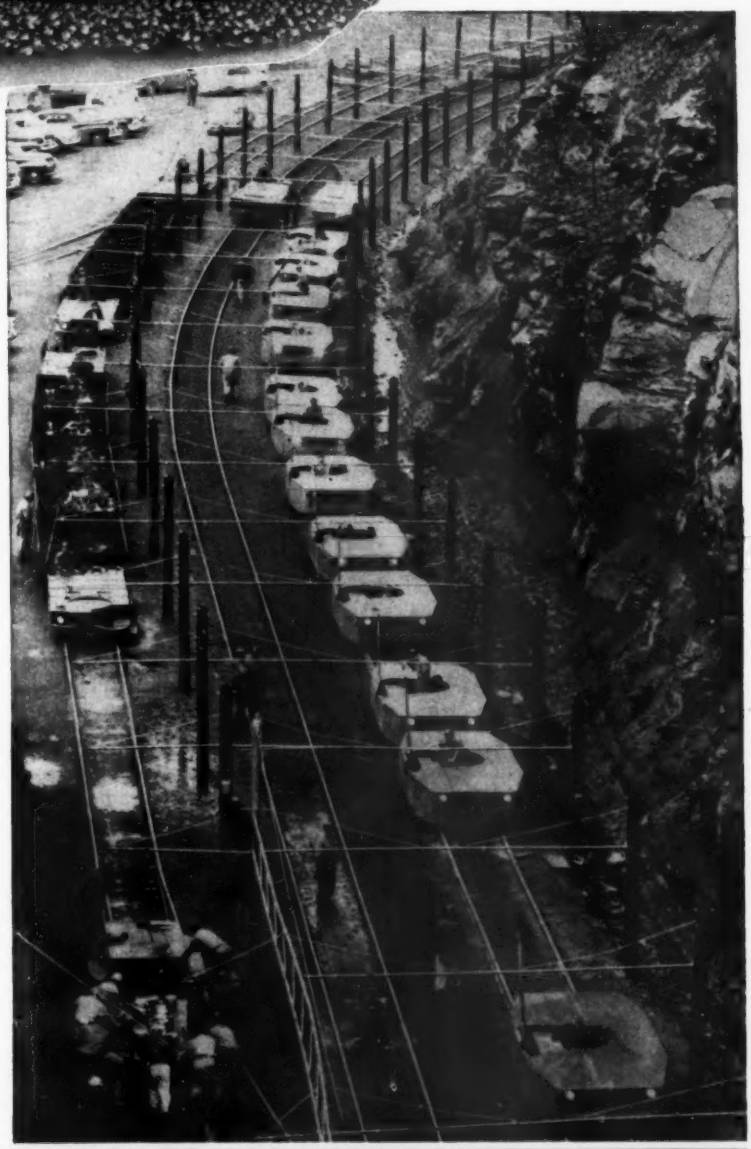


TJ5 Mine Portal Bus, "Low Type"

## Lee-Norse *Self-Propelled* MINE PORTAL BUS

Factual performance records prove that the Lee-Norse Mine Portal Bus can effect up to 50% savings in portal time . . . savings that result in more man hours at the section face . . . increased tonnage at a reduction in overall cost per ton.

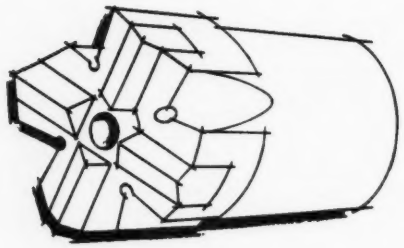
Built in low and high types to suit your haulage road, the Mine Portal Bus features complete safety —two separate braking systems . . . split-roof design that allows operator full vision at all times.



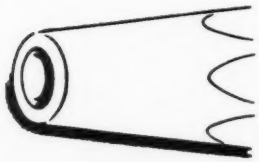
Get your personnel to and from the working face quicker . . . safer! Check the advantages of the Lee-Norse Mine Portal Bus.

**Lee-Norse Company**

CHARLEROI, PA.



Removable



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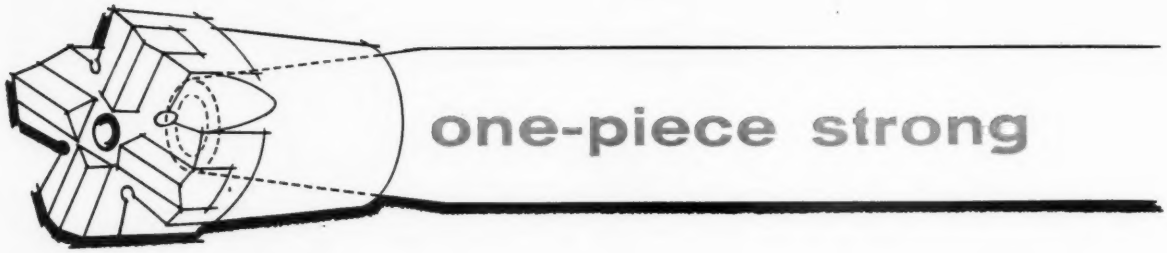


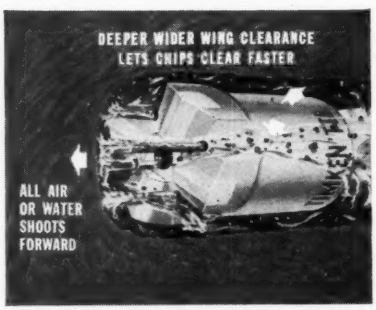
one-piece strong

# That's why the new Timken® air-leg bit cuts your drilling costs these 4 ways

1. You don't have to throw away good drill steels when the carbides wear out, the way you do with intrasets. The new Timken bit is removable!
2. You don't have to haul an armful of steel to the mine the way you do with intrasets. A pocketful of Timken removable bits is enough for a whole day's work.
3. You can change bit gauge sizes fast on the same steel with new Timken bit for air-legs. Using intrasets you have to change the whole steel.
4. You carry only the bit to the shop for resharpening—when it's a Timken removable bit. With intrasets you "fight" the whole steel and Timken bits give longer gauge wear because there are *four* carbide cutting edges. Most intrasets have only two.

Get all these savings in an air-leg bit that's *tapered* for one-piece strength. And get faster chip clearance, too (see diagram at right).

Specify the new Timken tapered socket carbide insert bit for air-leg drills. For free brochure write: The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*




**CHIPS CLEAR FASTER** because 1) five front holes shoot water or air directly against the rock face and 2) deeper, wider wing clearance lets chips wash back faster.

**TIMKEN®** AVAILABLE NOW!
**THE AIR-LEG BIT OF THE FUTURE!**

With dozer blade (8 other attachments available), Tournatractor quickly cleans pit-floor around shovel. Rubber-tired tractor's high working and traveling speeds permit it to get around to scattered shovels more times per day . . . also to keep pit-floor, haul-roads, and plant area smooth and free of loose rock for high-speed, low-cost, safe operation.

# Are rising costs for pit clean-up and maintenance cutting your profit margin?

With today's bigger pits and more widely-scattered operations, neglect of maintenance and clean-up can cut deeply into your profits. For example, it will increase haul costs . . . add impurities . . . and create an untidy pit that slows operations and invites accidents.

If you increase the number of your slow-moving clean-up tools, you add materially to operating costs. But there is an answer that will permit you to have a planned clean-up and maintenance program and also keep operating costs low. That is to put speed and mobility in this part of your operation. Here's a clean-up tool we think you should investigate — the high-speed LeTourneau-Westinghouse Tournatractor®.

This rubber-tired tractor can: (a) replace 2 or 3 crawler-tractors now handling pit-floor clean-up around your scattered shovels; (b) handle haul-road maintenance, construction and drainage problems to help your haulers travel at safe, *profitable* speeds; (c) help open up new areas of operation, build rail-beds, spot rail-cars, tow equipment; (d) clean-up around plant area, dress and seal stockpiles; and, (e) handle miscellaneous tractor assignments anywhere on your property quickly and at low cost. Here are the facts that back these important claims:

### "Go-anywhere" mobility

Speedy Tournatractor is never more than a few minutes away from its next assignment anywhere in your pit or plant area. This tractor always takes the shortest route — via rocky pit-floor, benches, down "shot" banks, over hard-surfaced roads, or cross-country. Unit's big, low-pressure tires do not damage air-drill hose lines, RR tracks, pavements. With rubber-tired tractors there are no delays or expense for flatbed loading and haul, even to a new work location many miles away.

### Completes job faster

Tournatractor's 17 mph forward speed is more than twice that of comparative crawlers. Instant shift and high reverse speeds to 7.2 mph are important, too — since nearly 50% of your working cycle on dozing or pushing jobs is usually spent backing up. On scattered assignments, tractor's fast travel and working speeds increase output by 50% to 100% over the *fastest* crawlers!

### Costs less to operate

With enclosed anti-friction drive and fewer moving parts, Tournatractor is better protected from grit and wear — will give you higher efficiency through more hard-working hours of continuous service.

Tournatractor rolls on only 4 rubber-tired wheels . . . compared to about 560 moving crawler track parts. In many materials, unit's big, pneumatic tires outwear tracks by as much as 2-to-1. In highly abrasive materials, tires often give up to 4 times the service of tracks.

### Try Tournatractor in your pit

Why not let us arrange for a demonstration? Put Tournatractor to work in your pit, and see for yourself how this rubber-tired tractor can help out clean-up and maintenance costs. Write for full details.

CT-1680-QM-1

**LeTOURNEAU-WESTINGHOUSE COMPANY,** PEORIA, ILLINOIS

*A Subsidiary of Westinghouse Air Brake Company*

**Where quality is a habit**

# How RYKON GREASE

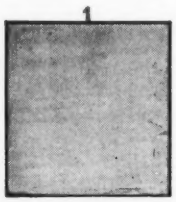
## *has performed in five tough applications*

## In just two years since introduction, RYKON Grease has stepped in to deliver lubrication in hundreds of applications where other greases have failed

The reason RYKON Grease can perform under conditions that cause other greases to fail is this: RYKON Grease has a unique non-soap, organic thickener. This thickener holds the oil between its fibers better than any other gelling agent. The thickener is able to withstand extremely high as well as low temperatures. It resists chemical action and remains stable under conditions of severe working and water washing. RYKON Grease has exceptional anti-rust properties.

RYKON Grease's unique properties make it truly multi-purpose. This leads to many worthwhile economies. With one grease to do possibly every grease lubrication job in a plant, there's no chance for application mistakes. Inventory and handling of many single-purpose greases is reduced or eliminated. Maintenance training and supervisory follow-up is greatly reduced.

More facts about RYKON Grease are yours for the asking. Call the lubrication specialist in your nearby Standard Oil office in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Illinois.**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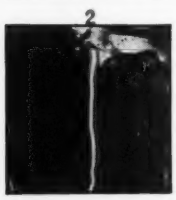
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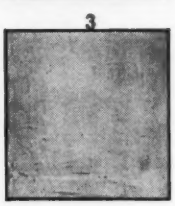
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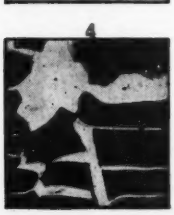
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In the mining industry, where higher speeds, loads, temperatures and pressures are being put on bearings as a means of increasing productivity of equipment, a new type of grease has been needed. RYKON is that grease. Here are just 5 examples of how RYKON Grease has performed in tough spots:

| Equipment | Type of Bearings | Conditions | Remarks |
|---|---|---|---|
| Tugger hoists, gears and bearings | anti-friction | high temperature, heavy load | Very good. Holds consistency under high temperature and heavy load. |
| Conveyors, cars, crushers, hoists | plain and anti-friction | high temperature, heavy load, wet, dirt | Excellent water resistance. Good stability. |
| Shovels, draglines, etc. | plain and anti-friction | high temperature, heavy load, wet, dirt | Replaced lithium greases. |
| Drilling rig | plain and anti-friction | high temperature, heavy load, wet, dirt | Replaced lithium greases. |
| Conveyor outside tipple | anti-friction | — — — — — | Permits cold weather start-up without knocking out breakers. |

*You expect more from* STANDARD *and you get it!*

**Oven test shows high temperature performance of RYKON Grease. 1. Metal panel coated with RYKON and placed in oven at 350° F. 2. Same panel after five days. RYKON is still soft and ready to lubricate. 3. Another high-melt grease ready for same test. 4. Same panel after oven test. Grease has failed completely.**

Maneuvering into or out of narrow, twisting underground tunnels is easy for LeTourneau-Westinghouse Rear-Dumps. Model D can U-turn in less than 25'. If roof clearance is 14'8" or more, "D" can raise bowl and turn in a tight 18'8" of clearance.

Fast, clean dump by 11-yd D Tournapull Rear-Dump speeds rock to crusher at Fort Hartford Stone Co., near Hartford, Ky. Electric motors, standard on all Tournapull units, raise and lower bowl with speed and safety.

# "Only units maneuverable enough to give us good production"

That's how Mr. A. C. Hall, owner of Fort Hartford Stone Co., Hartford, Kentucky, describes the 4 LeTourneau-Westinghouse D Tournapull® Rear-Dumps that move up to 225,000 tons of limestone a year from deep inside the firm's underground mine.

Three of the 11-ton-capacity L-W units are usually assigned to haul excavated rock from shovels working in the tunnels. They complete 6,000' round trips . . . one third of that distance inside the narrow tunnels . . . in an average of 12 minutes. Of this operation, Hall says: "Large trucks just can't turn in the working area. 'D's' are the only machines that can maneuver in the tight quarters of the working faces without stopping. It cuts lost time."

### Double-duty yard workers

Another "D" normally works in the open, stockpiling rock and gravel, and pushing rail-cars. At times, the whole L-W Rear-Dump force teams up with 2 front-end loaders to fill rail-cars in the yard. Rear-Dumps carry the material from crusher to stockpiles near the cars. Tractors then load it aboard. This "teamwork" loads a car in an average of only 12 minutes elapsed time.

### Six years of tire use

"D" maintenance is easy. Hall cites tire-life as an example. "Our first Rear-Dump was new when we bought it," he said, "and it was six years before we had to replace a tire.

"Whenever I've decided to buy another hauler, I've considered all makes carefully. And I've always decided on a Tournapull Rear-Dump."

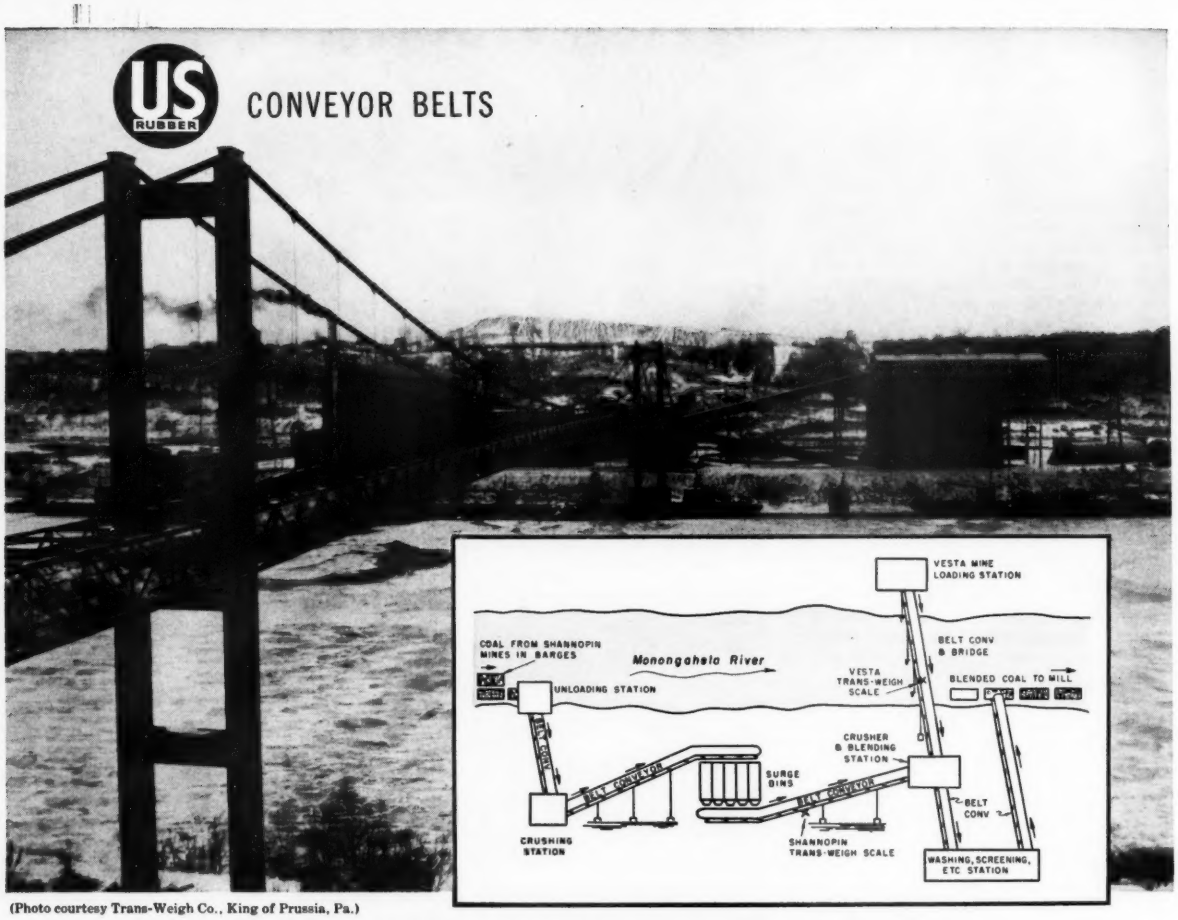
LeTourneau-Westinghouse Rear-Dumps are available in three sizes: the 138-hp, 11-ton "D"; 226-hp, 22-ton "C"; and 335-hp, 35-ton "B". Ask for a demonstration of the model best suited to your work.

DR-2006-MQJ-1

**LeTOURNEAU-WESTINGHOUSE COMPANY,** PEORIA, ILLINOIS

*A Subsidiary of Westinghouse Air Brake Company*

**Where quality is a habit**




(Photo courtesy Trans-Weigh Co., King of Prussia, Pa.)

# COAL CROSSES THE RIVER on a belt 3870 feet long

**Belt is now 11 years in service... has carried 44 million tons**

The Jones & Laughlin preparation plant at La Belle, Pa., is one of the world's largest. Here the output from the Vesta and Shannopin mines is combined.

Coal from the Shannopin Mine is carried down the Monongahela River by barge. Coal from the Vesta Mine is carried across the Monongahela on a 2000' suspension bridge equipped with a 3870-foot U. S. Rubber Belt. The bridge extends from the Vesta Mine loading station to the washing and screening plant. The "U. S." Belt on the bridge (actually, all the belts in this system are "U. S.", see flow chart) blends the coal from the two mines, mixing the coal in correct proportions to produce uniformly high-quality coal for coke production.

The belt crossing the Monongahela has been operating since 1948 and has been in continuous service all these eleven years. It has carried a total of 44 million tons so far. This belt, and the other belts in this system, demonstrate by their dependability and economy why "U. S." is the world's largest maker of conveyor belts.

• • •

**When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.**

**See "U.S." at Booth 801, American Mining Congress Coal Show**

US RUBBER

**Mechanical Goods Division**

**United States Rubber**

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

CATERPILLAR'S PROJECT PAYDIRT

***PROJECT PAYDIRT*** pays off again*

# NEW "ALL JOB" CAT NO. 619 225 HP TWO-WHEEL TRACTOR

**First two-wheel tractor to deliver four-wheel speed and roadability!**

**Matched with new No. 442 Series B LOWBOWL Scraper for new high production... 14 cu. yd. struck, 18 cu. yd. heaped!**

This new No. 619 Series B represents a major breakthrough in two-wheel tractor-scraper design. It is the first and only broad application two-wheel machine that combines two-wheel traction with four-wheel speed and roadability. It also affords new type unit construction and timesaving accessibility.

The No. 619's new turbocharged engine delivers 225 HP and a torque rise of 20%—for fast acceleration. With a top speed of 30.2 MPH, it can really run—and run under conditions that slow down other make two-wheel rigs.

That's because of its roadability. Advance Caterpillar design has achieved a tractor-scraper balance that "smooths out" rides to an amazing degree. This balance permits higher speeds for more cycles per day and less operator fatigue.

As for unit construction and accessibility, here's an example: A new swing-away dash allows ready access to the starting engine, air compressor and hydraulic pump. Entire left side of the engine can be exposed without having to disassemble any major components connected with the dash.

Like all achievements of Project Paydirt, the No. 619-No. 442 has been thoroughly tested. Four years of on-the-job operation prove this: This new "all-job" rig will set new performance records on a broad range of applications.

How much does this mean to you profit-wise? Of course, that depends on your jobs. But this is for sure. There's nothing like the new No. 619-No. 442 in the field today. Get the complete facts from your Caterpillar Dealer. Ask for a demonstration. See for yourself how it can step up production and profits on a wide range of applications.

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

* ***PROJECT PAYDIRT:*** Caterpillar's multimillion-dollar research and development program — to meet the continuing challenge of the greatest construction era in history with the most productive earthmoving machines ever developed.

## ADDITIONAL FACTS ABOUT THE NO. 619-NO. 442

**NEW NO. 442 SERIES B LOWBOWL SCRAPER** has capacities of 14 cu. yd. struck and 18 cu. yd. heaped. Exclusive LOWBOWL design provides a faster loading rate with less resistance throughout the loading cycle. Also available is the 25-ton-capacity Athey PR619 Rear Dump Trailer.

**UNIT CONSTRUCTION FOR EASY ACCESSIBILITY.** The transmission, differential and cable control can be removed from the tractor as a single unit. The flywheel clutch can be removed as a unit with the engine in place.

**PLANETARY FINAL DRIVES.** By removing six capscrews in the planet carrier cover, each axle can be removed from the tractor. Use of planetary gears has contributed materially to the over-all accessibility of the unit.

**OPERATOR EFFICIENCY IS INCREASED.** New 2-jack steering system provides a greater amount of turning effort *coming out* of a turn than *going into* a turn. Also, for reducing ride motion, the Torsionflex seat is supplied as standard equipment.

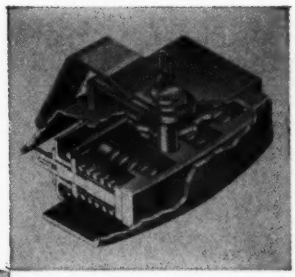
**WIDE RANGE OF APPLICATIONS.** The new No. 619 fits equally well on small jobs or large projects. Whether it is called on for a low-yardage finishing job or to move material at high speed, the No. 619 is the right machine.

**ALSO:** Six-speed forward, two-speed reverse constant mesh transmission • Standard wide-base 26.5-25, 24-ply tubeless tires all around—optional treads and ply ratings available • Choice of in-seat gasoline starting or direct electric starting • New dry-type air cleaner • Fuel tank capacity — 85 U. S. gallons • Shipping width — 10 feet, 10 inches.

**CATERPILLAR**

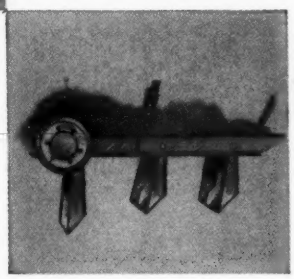
Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

BORN OF RESEARCH
PROVED IN THE FIELD



**acf DOUBLE-ACTION SPRING BUMPER**

**acf WELDED END SILL MEMBER**



**acf LUBRICATED DROP-BOTTOM DOORS**

# acf EXTRA-PERFORMANCE COMPONENTS
## increase haulage efficiency

**acf LOAD SUPPORT WHEELS**

Every **acf** Constant Haulage Mine Car—drop-bottom, end dump, or rotary dump—pays off in extra productivity, lower maintenance costs. No matter what type or size your operations need, from 20 to 30 tons or more, there's a service-proved **acf** design that's right for the job. Why not discuss your haulage problems with an experienced **acf** representative. Just contact the nearest **acf** sales office or write department MC-5.

*Write for this bulletin describing all types of* **acf** *Mine Cars available on request.*

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**AMERICAN CAR AND FOUNDRY**
DIVISION OF ACF INDUSTRIES, INCORPORATED
750 THIRD AVENUE, NEW YORK 17, N. Y.

***MINE CARS FOR CONSTANT HAULAGE.***

SALES OFFICES: New York • Chicago • Cleveland • Washington, D. C. • Philadelphia • San Francisco • St. Louis • Berwick, Pa. • Huntington, W. Va.

# NEW ACME HI-LIFT

MODEL HSHL-4B

## *For Best Results in High-Vein Roof Bolting*

The ACME (Model HSHL-4B) HI-LIFT is an innovation in modern mining technique designed to facilitate roof control in high-vein mining operations. The ACME HI-LIFT is a four-wheel drive, tractor type steering, unit with an elevating drilling deck on which are mounted two traveling and traversing Le Roi S12VT Nu-Matic stopers. The elevating platform enables the operator to work at the most convenient height for greatest efficiency. The stopers move on a traveling rail thereby permiting drilling at virtually any spot on the platform. The drills are of the integral dust collecting type and the dust collectors are mounted beneath, and on the sides of, the platform. Safety timbers can be placed between the platform and the roof to afford protection to the operator from roof slabbing and falls. The platform will support a 30,000 pound weight and can be tilted 15 degrees front to back. In addition the ACME HI-LIFT has four leveling jacks with an effective stroke of 10″ for leveling in bad bottom or on high grades. Two complete sets of controls are furnished as standard equipment, one being on the platform and one on the tramming deck. A powerful 40 HP motor drives the complete hydraulic system for the unit.

COMPLETE SPECIFICATIONS WILL BE GLADLY FURNISHED UPON REQUEST

ACME MACHINERY COMPANY

**ACME MACHINERY COMPANY**

WILLIAMSON, WEST VIRGINIA

WAREHOUSE AND SALES OFFICE
MORGANTOWN, W. VA.

REPRESENTATIVES IN PRINCIPAL MINING AREAS


# so National rebuilds and ships motor in 4½ days

FAILURE of this slip-ring induction motor threatened a shutdown of service. So the owner shipped the motor to National Electric Coil – to get it rebuilt fast and rebuilt right.

In just 4½ working days, here's what National did: *designed* and built both stator and rotor coils, rebabbitted the bearings, turned the slip rings, repaired stator laminations, rewound stator and rotor, dynamically balanced the rotor, performed complete checkout testing, crated, loaded and started the motor on its return trip!

For service when you need it, it's wise to have this responsible, competent organization on your electrical machinery team. Call or write for full information.

McGRAW EDISON

**National Electric Coil**

DIVISION OF McGRAW-EDISON COMPANY
COLUMBUS 16, OHIO

ELECTRICAL ENGINEERS • MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS • REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES


HAUMEE COLLIERIES

At the Maumee Collieries in Indiana...

# ANACONDA SHOVEL CABLE HAS A RECORD: 10 YEARS ON THE ROCK PILE!

## Anaconda's SH-D Cable gives many years of dependable service in spite of heat, moisture, kinks, rocks and runovers!

How many shovel cable hazards can you count in this picture from the Maumee Collieries? Rocks . . . moisture . . . kinks . . . danger of runovers—they're all there. Yet the first installation of Anaconda's rugged SH-D Shovel Cable has resisted them all—*for 10 long years!*

It's proof again of the way Anaconda's in-the-field experience with Shovel Cable pays off in a superior cable for you. The important knowledge gained from use and testing of SH-D Cable *on the job* in our own mines goes into the design and manufacture of Anaconda Shovel Cable.

For example, the insulation is Anaconda Butyl (AB). Nothing can beat it for withstanding ozone, heat and moisture. Patented rubber cores cushion the ground wires and help prevent breaks from kinks and runovers. SH-D has a neoprene jacket that is exceptionally tough and abrasion-resistant. And every design, every component has been job-tested—your assurance of superior quality and performance.

Call on the Man from Anaconda with your cable problems. Or see your local Anaconda distributor. For new descriptive Bulletin DM-5818, "Anaconda Securityflex Portable Cables for the Mining Industry," write: Anaconda Wire & Cable Co., 25 Broadway, New York 4, New York.

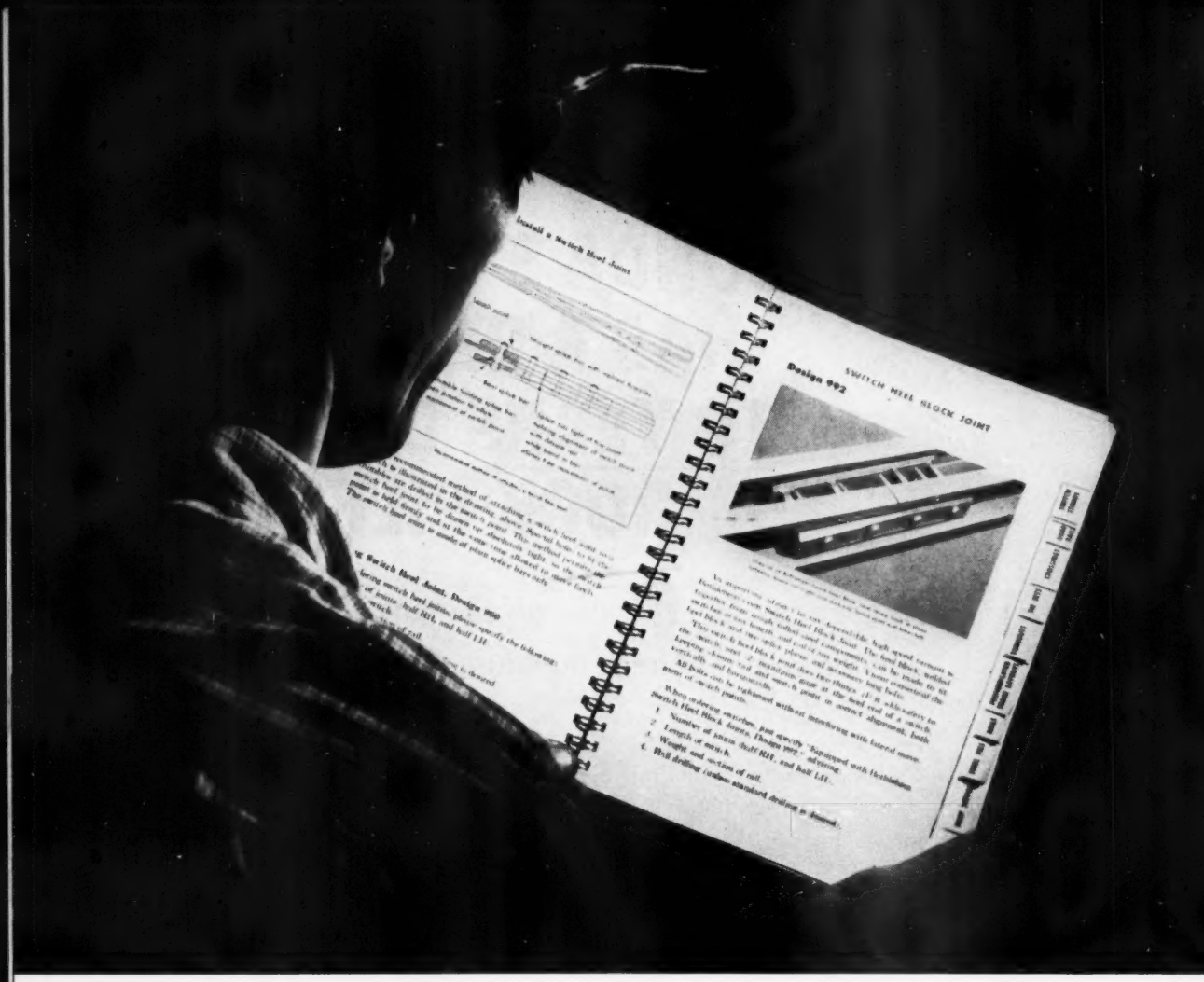
59212

◀ For a decade, the Anaconda SH-D Shovel Cable you see here has been giving dependable service for the Maumee Collieries, Jasonville, Indiana. Its many superior design features enable it to resist on-the-job hazards that would knock out ordinary shovel cables.

ASK THE MAN FROM

**ANACONDA®**

FOR **SHOVEL CABLE**

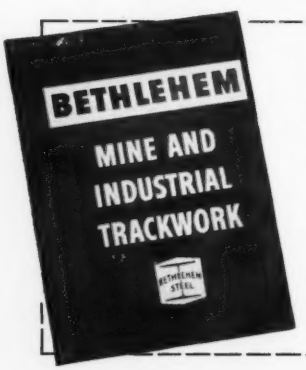



## Want this new trackwork catalog?

It's ready—the newest edition of Bethlehem's catalog of mine and industrial trackwork and accessories. In 204 heavily-illustrated pages, the catalog describes Bethlehem's complete line of track items for rails 20 lb to 100 lb per yard.

Included in this useful book are hundreds of drawings, plans and photographs, along with tabular data, descriptions and standards. Anyone interested in the design, construction or maintenance of haulageways will find this book a valuable addition to his shelf.

To get a copy, just fill in and mail the coupon below. We will give your request prompt attention. And when you have problems regarding your haulage track, just get in touch with the nearest Bethlehem office for solid engineering assistance.




Bethlehem Steel Company
Dept. 1041-A
Bethlehem, Pa.

Please send me a copy of your new Catalog 470, "Mine and Industrial Trackwork for Safe Haulage."

NAME_____

COMPANY_____

ADDRESS_____

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
*Export Distributor:* Bethlehem Steel Export Corporation

**BETHLEHEM STEEL**

BETHLEHEM STEEL

# MORE COMBINATIONS

## FOR MORE STOPING SITUATIONS

### 3 hard-hitting models

### 2 roof-pinning stopers

### A combination of feeds, chucks and controls to match every stoping problem

**Take your choice** of three powerful Gardner-Denver stopers: the versatile, lightweight Model R68; the rugged, mediumweight Model RB94; or the heavy-duty Model RB104.

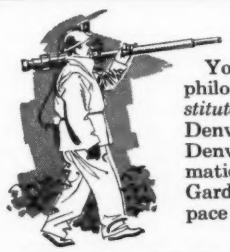
**All three** are outstanding in their class for high performance and low maintenance.

**They're easier to handle** . . . have balanced weight distribution. You may choose the feed control most suitable to your operation.

**For roof bolting,** specify a Gardner-Denver RB94 or RB104 roof-pinning stoper. They handle all operations quickly and efficiently—drilling hole, driving stud, tightening nut.

**Choose the right stoper combination for your work**

| Model | R68 | RB94 | RB104 |
|---|---|---|---|
| Hammer diameter | 2⅝" | 2¾" | 3⅛" |
| Direct feed (steel) | X | X | X |
| Direct feed (aluminum) | X | X | X |
| Telescopic, direct feed (aluminum) | X | X | X |
| Reverse feed | .. | X | X |
| Collared chuck | X | X | X |
| Tappet chuck | X | X | X |
| Push-button control | X | X | X |
| Rotary control | X | X | X |
| Stop rotation control | | X | .. |
| Roof-pinning adaptations | .. | X | X |



SETTING THE PACE

You'll find proof of our 100-year philosophy of growth—*there's no substitute for men*—in the Gardner-Denver stoper line. In 1906 Gardner-Denver men developed the first pneumatic up-hole drill—and ever since Gardner-Denver stopers have kept pace with mining needs.

Gardner-Denver R68

Gardner-Denver roof-pinning stoper

GARDNER-DENVER Since 1859 100 1959 YEARS

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

**GARDNER - DENVER**

Gardner-Denver Company, Quincy, Illinois
Export Division: 233 Broadway, New York 7, New York
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario


*Rear-Dump "Eucs" have payload capacities of 10 to 50 tons—are powered by engines of 128 to 670 total h.p. . . . have loaded speeds up to 41 mph.*

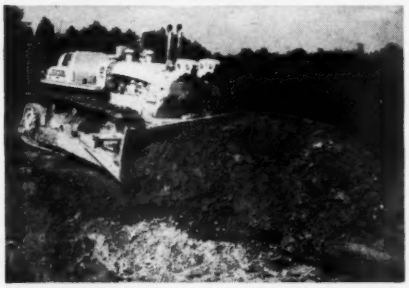
# *Check Euclid Performance for Lower Hauling Costs*

Leading contractors, mines, quarries and industrial users of heavy earthmoving equipment the world over have standardized on Euclids for tough off-highway hauls. They know from years of experience on their own operations that "Eucs" get more work done every shift — that production cost is lower than with other types and makes of equipment.

Euclid has a complete range of sizes and models to fit every job requirement — rear dump and bottom dump haulers, self-powered scrapers and the world's most powerful crawler tractor. Your Euclid dealer will be glad to provide a production-cost estimate on your present or planned operations — be sure to see him before you replace or add to your equipment fleet — and have him show you why Euclids are your best investment.

**EUCLID** Division of General Motors Corporation
Cleveland 17, Ohio

*Bottom-Dumps carry payloads of 13, 17 and 25 cu. yds. struck . . . are powered by 218 to 335 h.p. engines . . . have top speeds up to 34 mph. Full length, unobstructed door openings make these "Eucs" ideal for dumping free-flowing material into drive-over hoppers.*



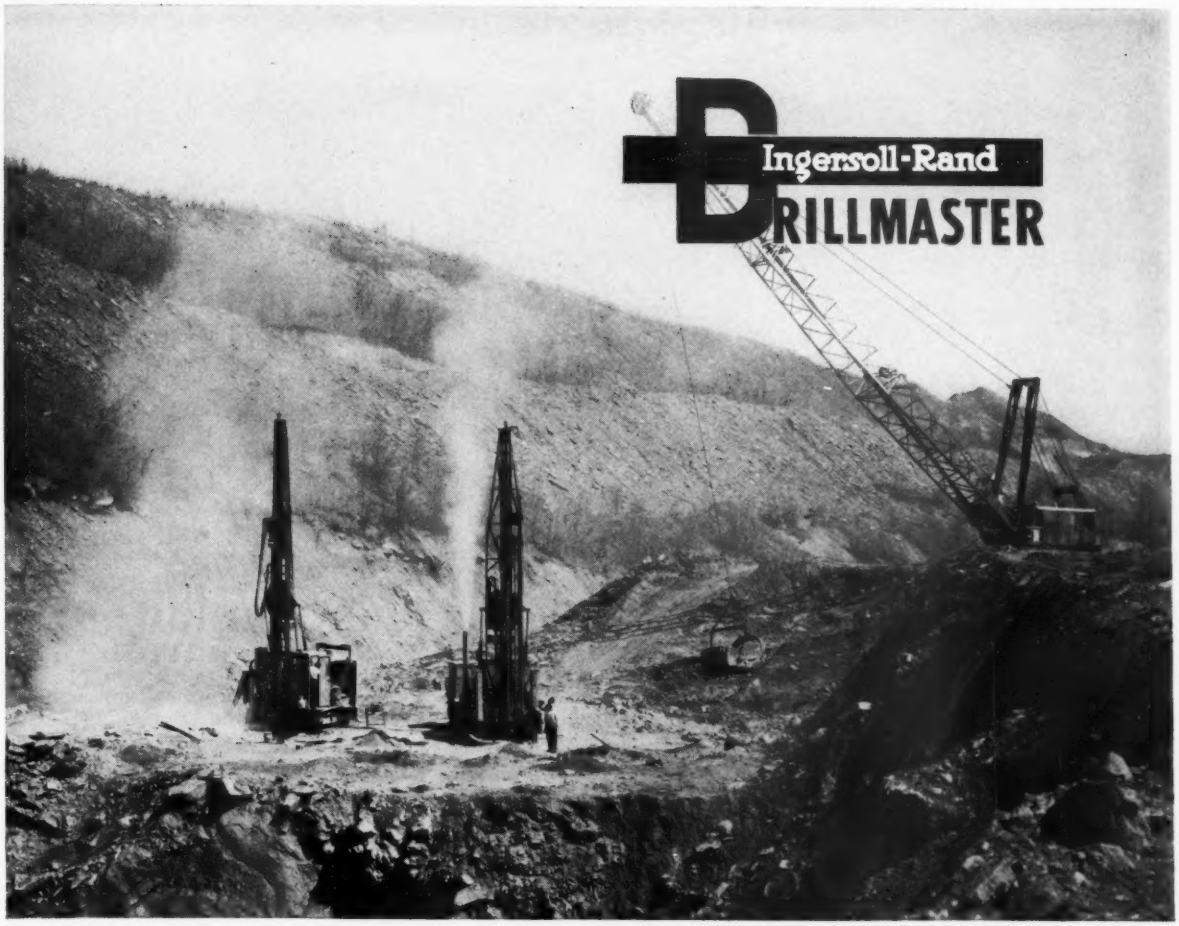
*The TC-12 Crawler has 2 engines and independent track-drive . . . 402 net h.p. . . . full power shift . . . top speed of 7.8 mph. This "Euc" tractor has unequalled work-ability for heavy dozing, ripping and similar work in construction, mining and logging.*

*This "Twin" Scraper has 2 engines with Torqmatic Drive . . . all wheel drive permits self-loading . . . struck capacity is 24 cu. yds. There are six other Euclid Scrapers, overhung engine and six wheel types, with struck capacities ranging from 7 to 24 yds.—9 to 32 yds. heaped.*

GM GENERAL MOTORS EUCLID

# EUCLID EQUIPMENT

FOR MOVING EARTH, ROCK, COAL AND ORE




## CRAWLER and TRUCM Units

# SPEED COAL STRIPPING

## at Newkirk Coal Mining Co.

To speed blast-hole drilling in hard overburden, Newkirk Coal Mining Co., Tamaqua, Pa., purchased a crawler-mounted DM-3 Drillmaster in 1957. This heavy-duty unit with the new Ingersoll-Rand DOWNHOLE drill proved so successful that a second Drillmaster, also with DOWNHOLE drill, was added in 1958. The latter was a TRUCM-3 unit with the rugged and roadable Crane Carrier truck designed especially for Drillmaster service. Both machines are used for primary blast hole drilling and fast mobility and easy setup of the TRUCM-3 unit makes it ideal for the company's other near-by operations.

Rock being drilled ranges from soft shale to extremely hard gray siliceous sandstone, but the DOWNHOLE drill maintains high penetration in any type of ground, for holes from 40 to 125 feet in depth.

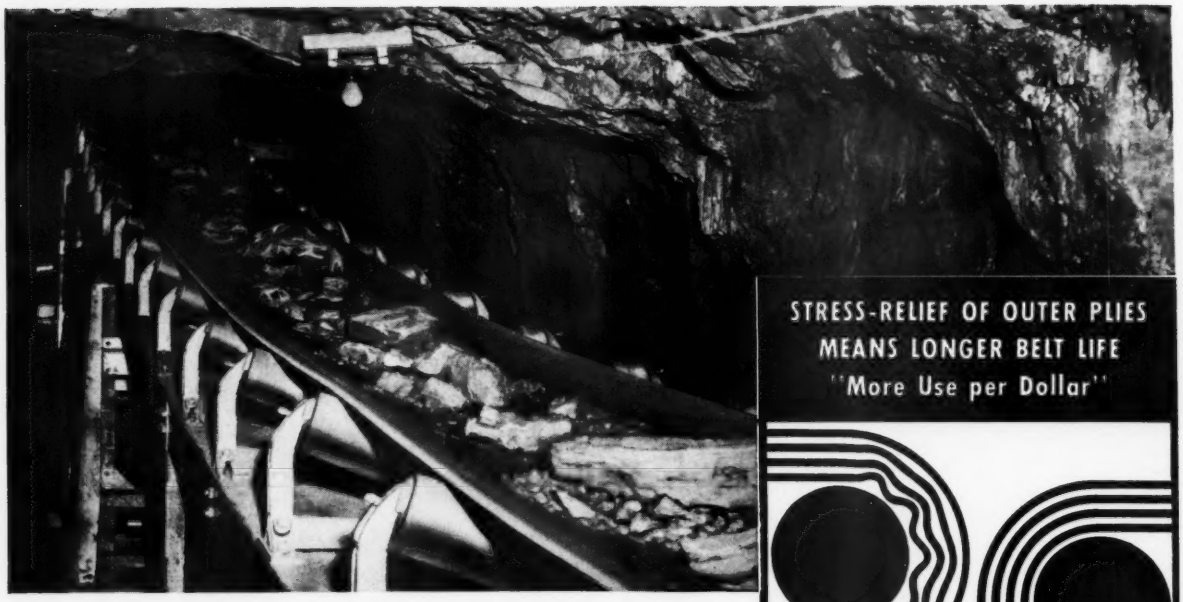
For coal stripping or any other open-pit blast hole work, the Ingersoll-Rand Drillmaster and revolutionary DOWNHOLE drill make a combination that has no equal for sustained high production at lowest overall cost. Ask your Ingersoll-Rand representative for complete information.

These two I-R Drillmasters, DM-3 on left and TRUCM-3 on right, average better than 140 ft. per 7 hour shift in siliceous sandstone so abrasive that Carset bits were reground every 25 feet.

**Ingersoll-Rand**

5-950 11 Broadway, New York 4, N. Y.

*A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR ROCK DRILLING*



STRESS-RELIEF OF OUTER PLIES
MEANS LONGER BELT LIFE
"More Use per Dollar"




**CONTROLLED PLY ELASTICITY**

Note how Double-Compensation at right equalizes ply stresses.

1. Center plies on neutral axis and better protected carry more load.
2. Outer plies stress-relieved by adjusting to tension and compression.

# RAY-MAN CONVEYOR BELT

## HAULS *MORE* COAL, LASTS *LONGER*

## *"More Use per Dollar"*

Special strength members with *double* compensation to relieve stress on outer plies, give Ray-Man Conveyor Belt unusual flexibility and longer life. It trains *naturally*, troughs *easily* . . . permits fuller, heavier loads even where thick, narrow belts are used, or where pulleys are small in low-head installations. Ray-Man requires no breaker strip . . . holds fasteners under the most severe conditions, has high rip-resistance and is mildew proof. R/M's exclusive "XDC" Cover provides *real* protection against wear, tear, cuts and abrasion. Like all R/M *underground* belts for coal mining, Ray-Man is available in special fire-resistant construction with Bureau of Mines' acceptance designation: "Fire Resistant, U.S.B.M. No. 28-10."

Let an R/M representative show you how engineered features of Ray-Man and other R/M heavy duty conveyor belts add up to "More Use per Dollar" on *every* job!

**For *More* Mine Drive Power in *Less* Drive Space—**
**Investigate patented R/M Poly-V® Drive. Write for Bulletin M141.**

**INDUSTRY'S *ONLY* COMPENSATED BELT**

Ray-Man Compensation relieves outer ply stress . . . allows outside ply to elongate more than inner plies as the belt flexes around the pulleys. Inner plies no longer "loaf", but carry full share of the load.

Outer ply is better able to absorb strain and impact of loading, pull as a strength member, *protect* the inner plies, hold fasteners or splice longer.

And, because Ray-Man is *double Compensated*—both top and bottom plies stress-relieved—Ray-Man Compensation prolongs belt life, even where operated over reverse bend, snub or take-up pulleys!

RM 812

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

**MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY**

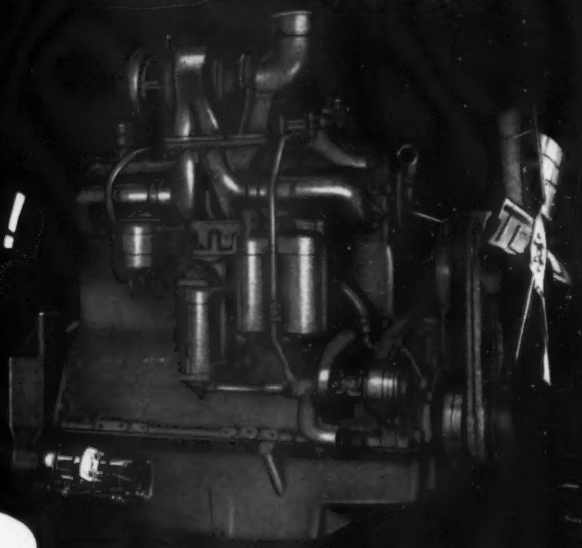
# RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

# New Allis-Chalmers Diesels...

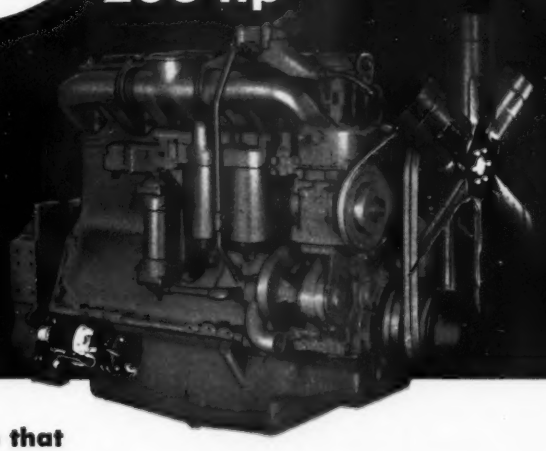
## We Told You They Were Good, BUT THEY'RE BETTER THAN WE SAID!

21000 — 340 hp Turbocharged



6 cylinders

16000 — 230 hp

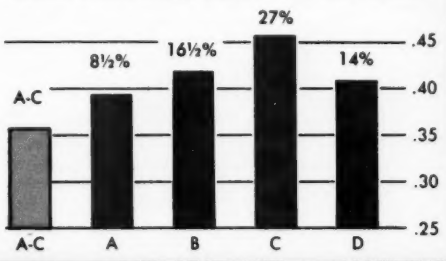


Actual field performance now proves that the new Allis-Chalmers 21000 and 16000 are *even better* than we announced. This fuel consumption chart illustrates the big advantage they give you in economy and efficiency, but it doesn't say enough.

**FUEL CONSUMPTION**

Pounds per brake hp hr.

Percent of fuel savings with A-C over other diesels




**Every day, reports from users prove that our original claims were understatements. Here are a few examples:**

**"Man, what Power** — a lot more than we ever expected," reports a construction company spokesman. "These engines have really got it!"

**"'Startingest' engine we've ever had,"** says a northern cement producer. "We threw away the ether can with temperatures way down below freezing — no external heating either."

**"We can hardly believe the fuel economy,** and it's doing heavy work, too," states a contractor. "Cleanest running engine we've ever seen."

**"Wish we had this engine in all our equipment,"** says a midwestern user. "We're doing a good 25 percent more work with it — on the same amount of fuel. It's almost unbelievable!"

Greater economy, top usable power, superior starting, plus a cleaner, tougher, more serviceable design — these will put more profit in performance *on your job.*

**Power *your* equipment with these new engines.**

For full details, see your dealer or write for bulletin BU-540. Allis-Chalmers, Milwaukee 1, Wisconsin.

BE-T4

# ALLIS-CHALMERS

***POWER*** **FOR A GROWING WORLD**

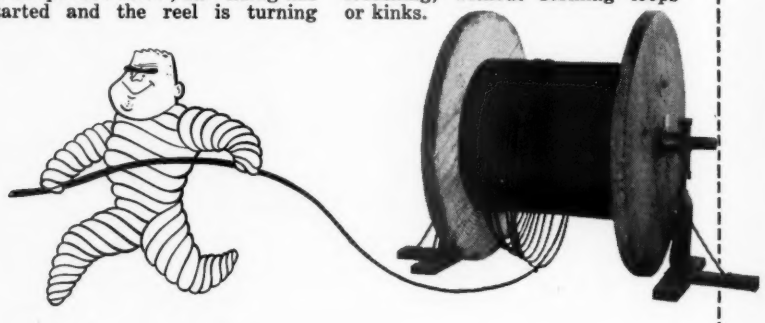
# Tuffy® Wire Rope Tips

More Damage is Done by Broken Rules Than by Broken Strands—

## *Rule 1:* RIGHT WAY to Set Up Reel for Unwinding

The stock reel should be set up on jacks, so the rope will come from the under side of the reel.

In the picture below, unwinding has started and the reel is turning faster than the rope is being pulled off. But no damage is done. Why? Because in coming from the under side of the reel, the rope is simply loosening, without forming loops or kinks.



### Tuffy Balanced Dozer Rope

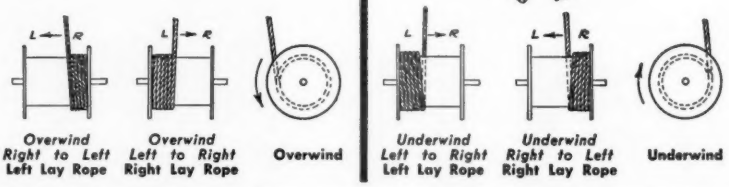
Built to give you longer service with less downtime. Mounted on your dozer, a 150' reel of ½" or 9/16" can give you a big bonus of extra service. Here's how: when rope shows drum wear or is crushed on the drum, you feed through just enough to replace the damaged part. You save the 40 to 50 feet ordinarily thrown away. Also available in 300' and 500' reels.

## *Rule 4:* What's The Correct Lay for Each Type of Winding?

"Lay" refers to the direction of the strands in wire rope. It's a **right** lay rope when the strands pass from left to right across the rope. It's **left** lay when they pass from right to left.

The direction of winding on the drum is determined by standing behind it, looking toward the direction of rope travel.

When winding one layer only on a smooth drum, the right and left lay ropes indicated in the drawings below will give the best service.


*Overwind Right to Left* **Left Lay Rope**

*Overwind Left to Right* **Right Lay Rope**

**Overwind**

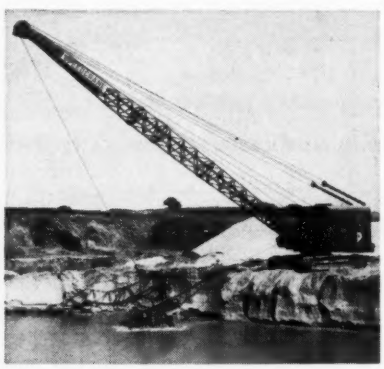
*Underwind Left to Right* **Left Lay Rope**

*Underwind Right to Left* **Right Lay Rope**

**Underwind**

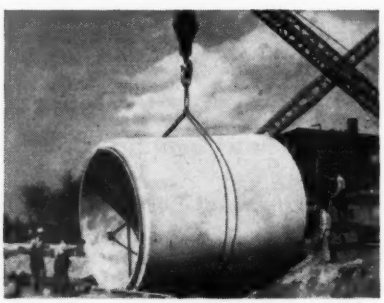
### Tuffy Balanced Scraper Rope

"Balanced" construction makes it flexible enough to withstand sharp bends, yet stiff enough to resist looping and kinking when slack. Also gives higher resistance to the shock of load impact on slack line. Moves more yardage per foot because it's specially built to take the beating of drum-crushing abuse.



### Tuffy Balanced Dragline Rope

Here's highest abrasive resistance with super flexibility. Better spooling. Smoother riding on grooves. And Tuffy Dragline Rope hugs the drum when casting for full load. Gives you longer service life, consistent dependability, in handling any material — wet or dry dirt, sand, gravel, rock, cement or minerals.



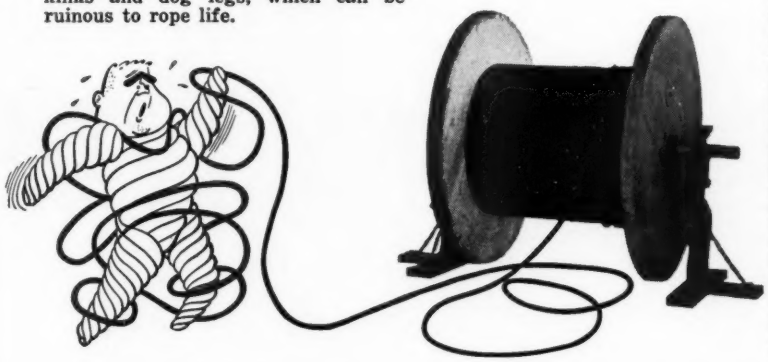
### Tuffy Balanced Slings & Hoist Lines

"Balanced" because they combine strength, flexibility and toughness in the proper relationship to do a better job longer.

Tuffy Slings and Hoist Lines are a top-performing team in every type of materials handling. The slings are made of a patented, machine-braided fabric that's next to impossible to knot or kink. The hoist lines are a special construction in which strength, flexibility and toughness are balanced.

## *Rule 2:* WRONG WAY to Set Up Reel for Unwinding

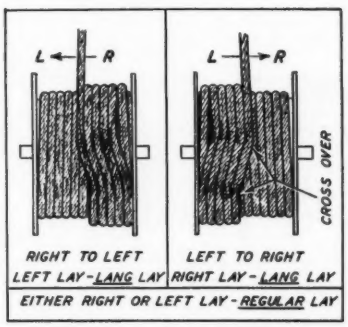
The rope is coming from the top of the reel and forming loops as it overruns. These loops are likely to form kinks and dog legs, which can be ruinous to rope life.



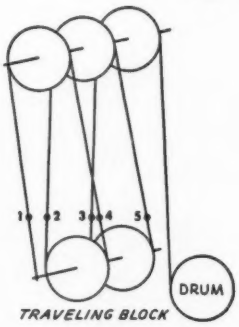
**Rope for multiple layer winding:** When a rope winds in the first layer across the face of a drum, it usually forms a uniform helix. On reaching the flange of the drum, the rope rides upon the last turn and starts winding back across the face of the drum, but falls into the depression of the successive turns of rope on the first layer.

Advancing across the drum on the second layer, the rope, following the depressions of the first layer, actually winds **back** a turn in each revolution of the drum. It must then cross over **two** depressions of the first layer to have a net advance of one turn per revolution.

This cross over is unavoidable on the second and succeeding layers. Severe punishment of the rope results, due to abrasion of the adjacent turns against each other, and the crushing from the next layer above at these points. Parallel-grooved controlled cross-over drums minimize this condition.




## *Rule 3:* How to Figure Reeving Loads




Reeving ropes through the sheaves multiplies the number of parts supporting the load. The lead line to the drum carries the weight of the load lifted, divided by the number of parts, plus the accumulation of friction on all sheaves.

To count the number of parts supporting the load, draw an imaginary line across the parts of the rope supporting the load.

The efficiency of reeving systems ranging from one to eight parts is shown in charts which Union Wire Rope engineers make available to users.

## *Rule 5:* Use the Tuffy Special Purpose Wire Rope "Tailored" to a Specific Application

There was a time when just any size and lay of rope was cut from a stock reel and used for just about any kind of service. It's different today. The various constructions of Tuffy Ropes are precisely fitted to each type of use.

There are thousands of different wire rope constructions. Union Wire Rope makes them all. But there's only one Tuffy line of ropes. Each Tuffy is the right rope and the best rope for the particular work for which it was developed. Each is "job prescribed". Each has the right balance of strength, flexibility and toughness to give you longest service, greatest efficiency and safety.

Union Wire Rope Corporation, Subsidiary of Armco Steel Corporation. Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand. 2144 Manchester Avenue, Kansas City 26, Mo.

***Your Tuffy Distributor Can Help You Get Longest Service Life and Cut Rope Costs***

**UNION** Wire Rope

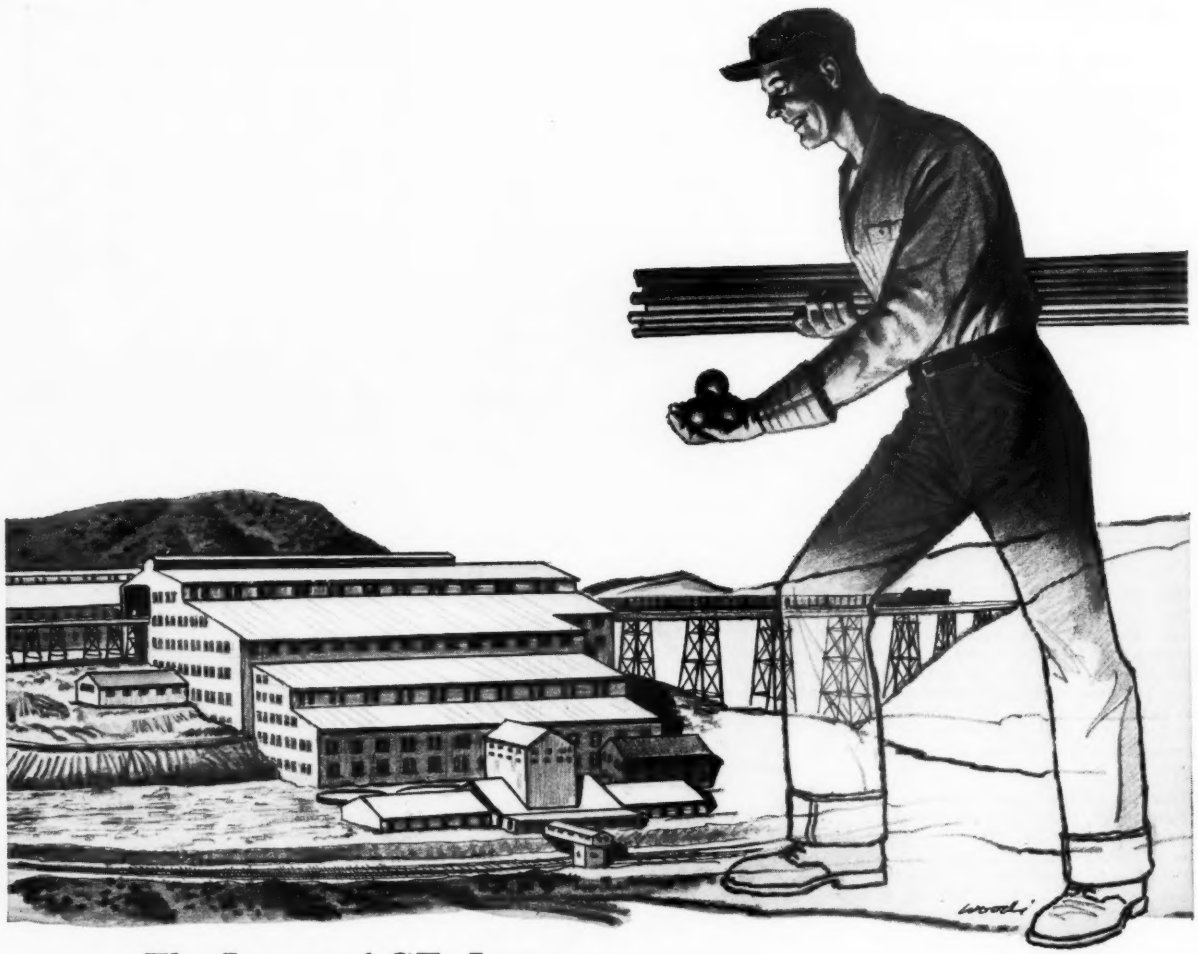
ARMCO

*Subsidiary of* ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company
Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Southwest Steel Products

New steels are born at Armco

3



*The Image of CF&I assures*

## quality steel Mining Products

This Image—the CF&I giant—stands for hundreds of dependable steel products used by many industries. And the CF&I name is prominent in the mining industry for such top-grade products as grinding balls and grinding rods.

For instance, the special analysis, hot-forged steel used in CF&I Grinding Balls gives uniform wearing qualities... high impact and abrasion resistance... maximum grinding efficiency.

CF&I Grinding Rods are hot-rolled from steel of special analysis, determined through years of experience to provide a hardness for high wear resistance, yet with a toughness to exclude bending or premature breakage. All rods are machine-straightened and their ends cut square so that they will freely rotate in the rod mill for better grinding.

We suggest you contact the nearest CF&I sales representative. He'll be glad to discuss your grinding problems with you, or give you complete information on all CF&I Mining Products.

**OTHER CF&I STEEL PRODUCTS FOR THE MINING INDUSTRY**

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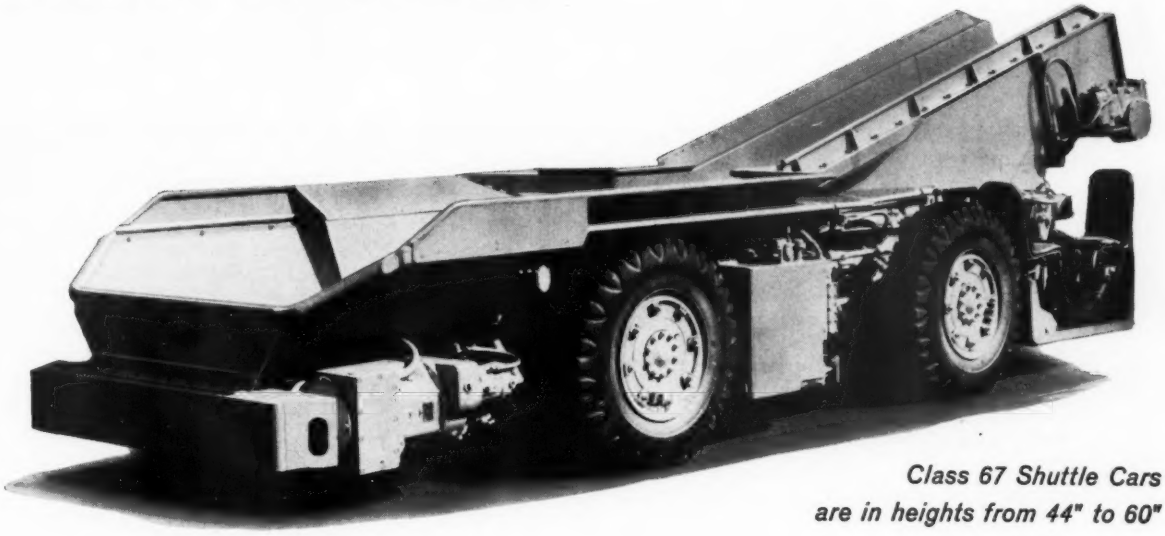

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The new boom arm design and positioning insures complete operator safety since all moving parts and pivot points are located forward of the operator's compartment. The stability of this new H-120 "PAYLOADER" is helped by the use of special high strength, light weight "T-1" alloy steel in the boom arms. Capacity loads can be carried close to the machine with a 40° bucket tipback at ground level and a flat 75° position at average carry height.

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With power steering, power air brakes and power-shift transmission, this big tractor-shovel operates easier than many smaller units.

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Easily removed panels expose electrical connections and batteries on one side — give access to hydraulic system controls and reservoir on the other. Daily or periodic checking and servicing points are easy to reach.

### Two-Stage, Dry-Type Air Cleaner

An important engine protective feature of the new H-120 is the Donaldson "Donaclone" two-stage, cyclonic precleaner and filter air cleaner. It keeps out 99.8% of the dirt — maintains high efficiency regardless of engine speed, temperature changes or dust accumulation, requires 75% less service time.

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The H-120 is powered by a CUMMINS NRT-6BI turbo-charged diesel engine developing 300 H.P. at 2,100 rpm. It handles full load of both torque-converter and hydraulic pumps without "lugging down".

The power-shift transmission has four speed ranges in both directions including travel speed up to 28 mph. Exclusive dual brake controls give driver the choice of braking with or without transmission engaged.

### More Reach and Dumping Height

At maximum dumping height this new "PAYLOADER" has 14'6" clearance to the hinge pin and 10'10" clearance with the bucket dumped at 50° angle. In this position the reach from the front tires is 42".

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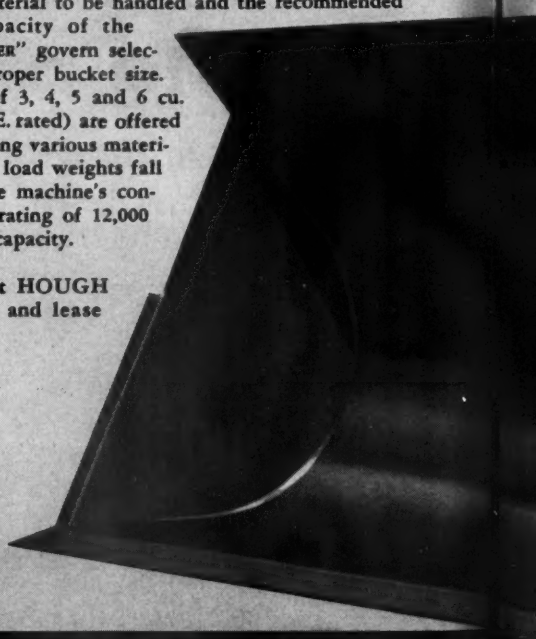

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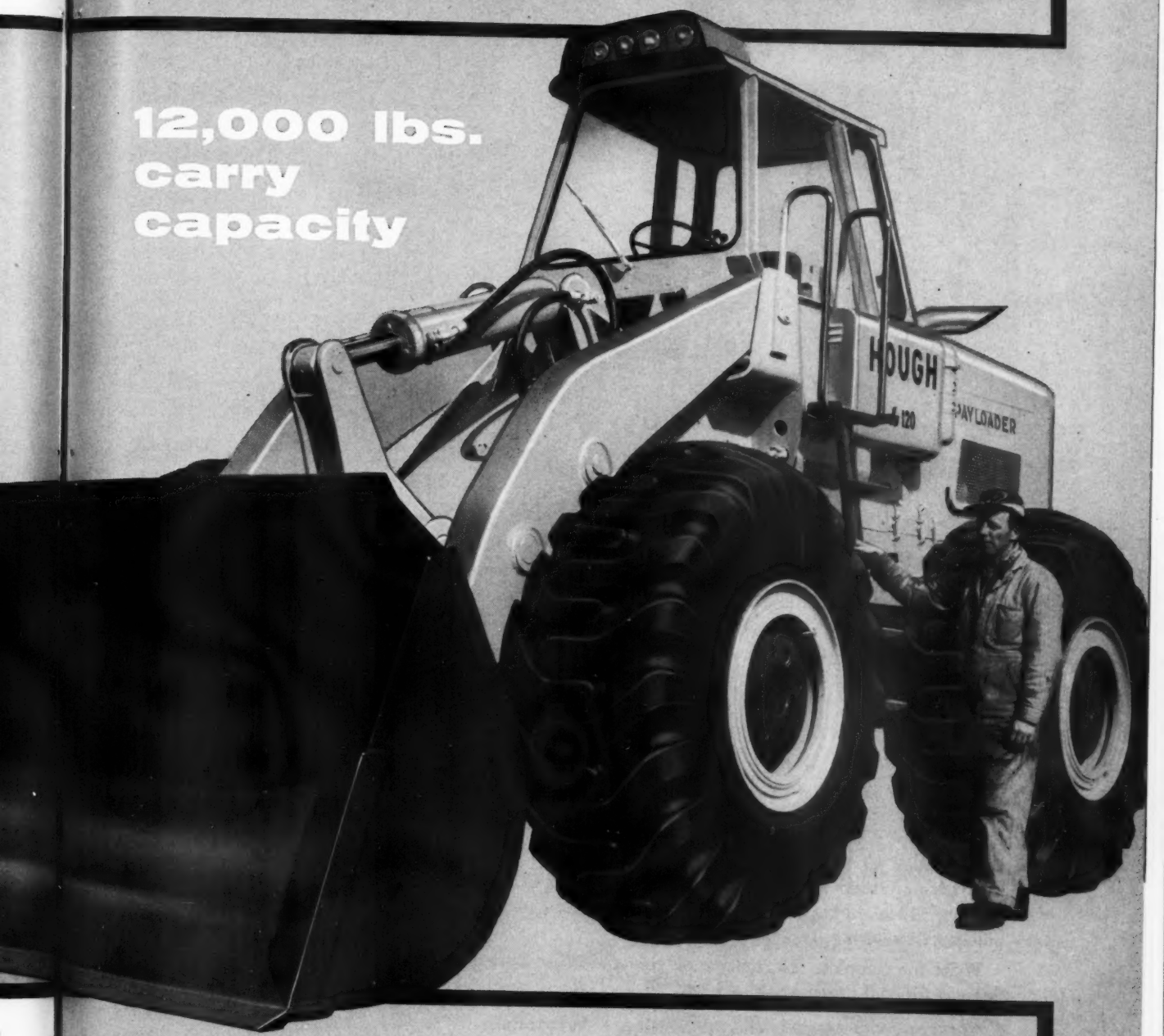


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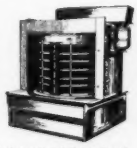

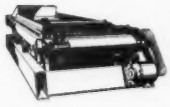

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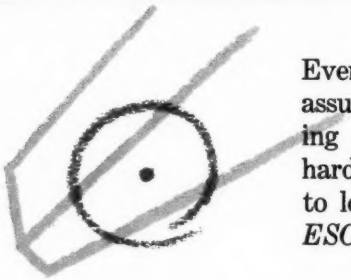

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# EDITORIALS

ROBERT W. VAN EVERA, Editor

MAY, 1959

## Coal by Wire

"Will the ability to transmit higher voltages of electricity over longer distances play an increasingly important role in the location of future power plants"?

A. W. Vogtle, vice president, DeBardeleben Coal Corp., presents a keen analysis of this question in the March 26 issue of *Public Utilities Fortnightly*. Entitled "Coal by Wire," the article traces the progress in long-distance transmission of electricity in the past two decades and emphasizes the possibility of carrying electricity instead of fuel to consuming centers.

Transportation, a big cost factor in the price of coal to utilities, is cited as one reason why the development of extra-high-voltage transmission may well affect the plant location pattern of power companies which generate steam by the burning of coal. "By materially reducing or eliminating this cost through an economical, close-to-fuel location and the use of long-distance high-voltage power lines, a utility might well keep its production costs at an attractively low level," Vogtle said. He also notes that suitable plant sites near large metropolitan load areas are becoming increasingly scarce and expensive.

As an outstanding example of progress in the field of high voltage transmission, Vogtle credits the 345-kilovolt lines of American Electric Power Co. with providing power reserve that brings important economies in capital and operating costs. This company's seven-state system, largely interconnected with 345-kilovolt line, "joins the giant new steam electric plants at the eastern and western boundaries of the system—the Carbo plant at mine mouth in Virginia, and the Breed plant in Indiana, receiving its coal from a mine some ten miles distant over a private railroad."

Another prime example of "coal by wire" involves the Barry plant of Alabama Power Co. near Mobile and Gulf Power Company's coal-burning plant at Boykin in northwest Florida. Boykin's rail rate on coal is $1.57 higher than the transportation cost to the Barry plant, some 150 miles west. It is not surprising that a 230-kilovolt transmission line draws on Barry's lower cost power to serve the growing requirements of northwest Florida.

Vogtle also points out that improvements in mining equipment and methods have stabilized the mine prices of coal to electric utilities and "assure an adequate year-around supply, free of sharp fluctuations for the long future."

Coal's future is tied largely to the electric utility industry, and "coal by wire" could well be opportunity knocking on coal's door.

## Investment in Manpower

Your attention is called to the article beginning on page 75 of this issue, "Training Young Engineers" by Robert O. Hawkanson, Vice President of Oliver Iron Mining Division, U. S. Steel Corp.

Because the Oliver Iron Mining Division is one of our larger mining organizations, the program which it uses to recruit, orient, train, and then find the best spot for its young engineers is somewhat formalized, and certainly very complete. But it seems to us that in some degree at least, every mine operating organization down to the very smallest must accomplish the things that Oliver's program is designed for.

In many smaller companies such matters as giving the trainee experience in various departments are almost automatic because of the closeness of the young man's position in the organization to the over-all operation. In these instances a formal training program is probably not warranted.

But what about the young engineer in the medium-sized, fast-growing company? He should certainly be given a chance to learn all about the company he serves. His progress must not be allowed to falter because of the absence of any clearly defined personal development program. There is little doubt that alert managements, so characteristic of the mining industry, are fully mindful of the value of young technical employes and of the industry's responsibility to them. In some cases, all that is lacking is a plan to accomplish the desired goals. Here's where Hawkanson's article may be extremely helpful to all supervisors, because it describes a complete training program—one that has worked successfully for more than a decade.

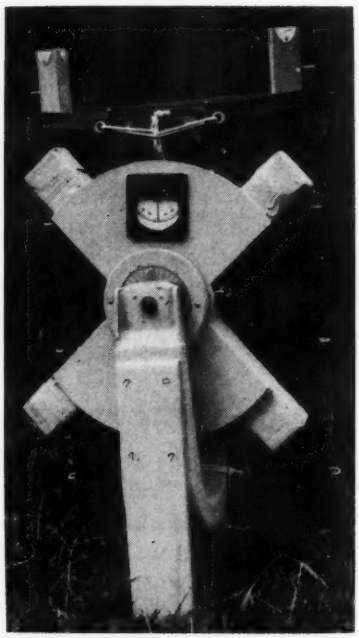


Fig. 1. Pack-sack mounted electromagnetic AFMAG receiver

**Statistical determination of the "probability of discovery" of geologically interesting areas is a subject which deserves much more attention, because random searching with expensive equipment and techniques all too frequently produces fruitless and costly results. Once a well-reasoned exploration program has been decided upon, however, management should be prepared to continue it until the program has had a sufficient chance, statistically, to provide a discovery**

# Mining Geophysics

By

**LOUIS B. SLICHTER**

**Director**
**Institute of Geophysics**
**University of California**

IT is convenient to distinguish three major aspects of exploration geophysics: (A) Instrumentation, (B) Interpretation, and (C) Prediction. Under the heading "Prediction" are included appraisals of field situations in terms of probable values capable of discovery, and the estimation of the expectation of profit or loss in exploration ventures. Thus this subject is broad and complex. It appears to offer much opportunity for future cooperative development by geologists, geophysicists, and statisticians. The first two topics will be examined briefly, to permit more opportunity for discussion of the third.

## Instrumentation

**Magnetometers:** The airborne magnetometer, which was developed during the war, produced the most revolutionary changes in magnetic prospecting that this old art has ever experienced. In the search for ore alone, nearly a million miles of traverse have been flown. Significant new instruments continue to appear. The nuclear resonance magnetometer provides absolute readings basically free of temperature effects (although auxiliary equipment may not be immune). This magnetometer represents completely new principles in magnetic measurements, and offers an ideal means for comparing absolute values of the earth's magnetic field at widely separated points. Fortunately, the severe instrumental requirements for magnetometers for use in artificial satellites are the same as those for prospecting instruments —a rugged, sensitive, reliable instrument of minimum size and weight is required. Clearly there is great incentive here for developing instruments of outstanding quality.

Conventional field magnetometers are also being improved. Instruments of the quick reading null type have been introduced in which the knife edge suspension has been replaced by the more rugged and reliable elastic suspension used so successfully in gravimeters. These improved magnetometers are lighter, faster, and more reliable versions of the original Schmidt field magnetometer.

**E.M. Equipment:** For ground surveys, when the ore bodies are at moderate depth (100 to 200 feet or less), the speed and convenience of operation obtained in simple, lightweight, battery powered equipment is usually very advantageous. An efficient electromagnetic system of this type developed by the New Jersey Zinc Co. has been briefly described in the literature.[1] Adequate horizontal ranges of 500 to 600 feet may be obtained, and in good country only two men are needed to operate the system.

During the last half dozen years, the introduction of airborne e.m. systems has provided revolutionary means for searching large areas rapidly and economically. This development is comparable in its field to the introduction of airborne magnetic

surveys; but the wide distribution of magnetite of course gives the magnetic method a universal value in structural studies not enjoyed by e.m. methods. Airborne e.m. systems appear to be still in process of significant improvement and development. The use of phase-shift criteria has proven valuable in the identification of the response from good conductors and for the estimation of the effective conductivity of anomalous conducting structures. However, several disadvantages of an e.m. airborne operation, especially in the search for ore bodies of moderate or small size, should be noted. (1) The distance to ore is significantly increased by the necessary elevation of the equipment above the ground level. (2) The geometrical configuration of the source, receiver, and ore body, which is largely fixed by practical considerations related to the aircraft is *not* ideal for purposes of detecting the ore. The observed response diminishes rapidly with increasing distance to the target, and with diminishing size of the target. The use of helicopters reduces the handicap of the flight elevation, but when access to the ground is convenient, conventional e.m. ground systems still seem to provide the most flexible and effective e.m. method of detecting small ore bodies.

**Use of Natural Fluctuations of the Earth's Magnetic Field:** Important progress in e.m. prospecting techniques has recently been reported[2] by S. H. Ward and associates. In the so-called AFMAG method the conventional e.m. source is eliminated entirely, and instead the natural fluctuations of the earth's magnetic field are used as a source of induction. This puts the method on essentially the same basis in respect to field operations as the ordinary magnetic method—only a receiver is used, which, like a magnetometer, can be operated by one man (see figure 1). Thus delays associated with the coordination of the positions and orientations of source and receiver in the conventional e.m. method are avoided. Furthermore, in airborne operations the elimination of the local source may significantly increase the depths at which ore bodies can be discovered. In either ground or airborne operations, favorable frequency bands may be selected from the natural noise-like source field. The development of this method provides another example of the valuable cross fertilization which exists among diverse fields of geophysics. For many years natural magnetic fluctuations have been studied as a source of information about the ionosphere. It is interesting that these studies of the high atmosphere are now serving a double purpose by also assisting the exploration of the solid earth.

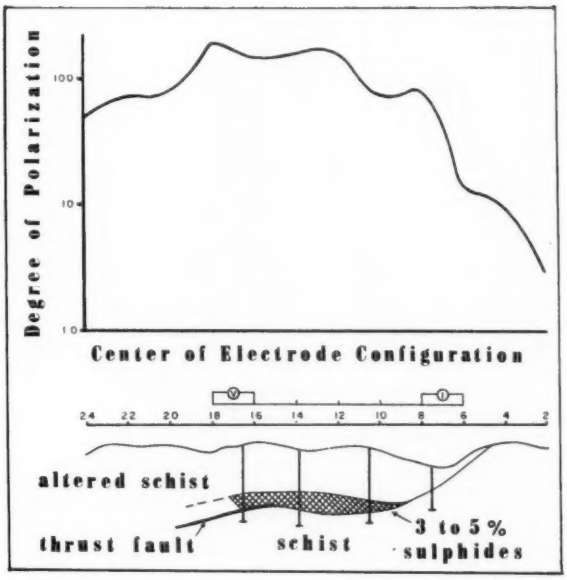



Fig. 2. Detection of disseminated sulphides by induced polarization method

**Induced Polarization Methods:** The induced polarization method has achieved successes in the solution of a common type of exploration problem which is completely beyond the capacity of conventional d.c. or e.m. conductivity methods. Namely, the method is applicable in the search for non-conducting disseminated ore composed of minor percentages of conducting particles present in amounts as low as 10 percent or less. The induced polarization method utilizes the fact that electrical conduction in almost all rocks and minerals takes place through the transport of ions in the minor amounts of water present. If metallic conducting particles are present (which are commonly base metal sulphides), and an electric current is passed through the rock, these particles become charged at their interfaces. When the source current is turned off, a counter-current flows momentarily as the particles are discharged, and this current may be observed during the periodic intervals when the source-current is either zero, or being reversed at low frequency.

In figure 2, results of measurements, taken by McPhar Geophysics, Ltd., above a disseminated ore body containing three to five percent sulphides are shown. The depth to ore as indicated by the scale to the upper right was about 250 feet. To the right of station number 10, where the drilled ore body pinches out, the curve showing the degree of polarization drops to a value less than three percent of its value over the ore.

**Gravity at Sea:** An amazing instrumental development has come to the test stage within the year in the use of gravimeters aboard surface ships. Of the several recent sea trials of Graf and LaCoste-Romberg gravimeters, the most significant seems to be the test in November 1958 of the LaCoste-Romberg gravimeter *without benefit of a stabilized platform*. This test was made off the coast of Southern California aboard the small oceanographic vessel Horizon of the Scripps Institution of Oceanography. This ship is 143 feet long, has a 14-foot draft, and displaces 967 tons. In three hundred miles of track 250 readings were obtained, at an average spacing of about 1¼ miles. At 13 of these stations, comparisons with previously occupied submarine stations were available. These showed a mean difference of seven milligals, which is about the same as the difference to be expected because of navigational errors alone. The development of gravimeters for use on surface ships promises to reduce by a large factor the time and cost of obtaining gravity readings at sea. The present limitation on sensitivity indicates that the first applications will consist in the mapping of the gravity field above large scale struc-

To achieve stability in the prospecting business, it is essential to adopt the philosophy of insurance companies, who spread their risks over a large number of ventures

tural features, and in completing adequate gravity maps of the ocean basins.

### Interpretation Theory

The geophysical methods most generally used in mining geophysics are the so called flux methods—gravity, magnetic, d.c. and e.m. Over the years the theory of the behavior of these methods under different postulated field conditions has been developed in detail, through scale-model experiments, and from mathematical solutions of specific problems. Solutions of additional cases tend to expand the field of application of the geophysical prospecting methods and to improve the reliability of the interpretations. For example, the proper interpretation of electrical resistivity logs in rocks which are anisotropic in respect to their electrical conductivity obviously is dependent upon the analysis of current flow problems in such media, such as the recent study by K. S. Kunz and J. H. Moran.[3] As a second example, computations[4] concerning the response of a layered earth to an electromagnetic dipole provide the basis for an e.m. method of finding the depth to water table, or to bedrock, which dispenses with the grounded electrodes and associated long cables needed in the conventional four electrode method. The e.m. method provides the advantage of superior mobility and speed. Since the e.m. dipole field is more localized in space, and the method permits a richer variety of independent field observations—i.e., phase and amplitude measurements of the magnetic field components at different appropriate frequencies—one would expect that the e.m. method would yield interpretations of superior reliability. Much remains to be done in determining the better ways of obtaining and using this variety of possible field observations.

In the ideal method of interpreting a geophysical survey, the observational data would be directly processed by appropriate analytical procedures to yield the values of pertinent physical properties at depth. The only example of a successful direct method of interpretation of this kind is the well known Horglotz-Bateman-Wiechert theory for interpreting refraction travel time curves in terms of seismic wave velocities in the earth's interior. It is known that direct procedures are theoretically possible in the case of some d.c. and e.m. methods, but in practice the procedures involved have proven impracticable. Recently, however, new analytical methods have been proposed[5] which seem to be much superior. These new studies in the theory of interpretation are especially welcome, because this difficult basic field has remained relatively unproductive for so long.

### The Estimation of Prospecting Expectations

Granting that the crystal ball may be wrong, the author would like to suggest that probability and statistical considerations will become much more important in guiding prospecting plans. The development of new scientific prospecting tools of many kinds multiplies the opportunities for the investment of prospecting funds; and many of these tools such as the airborne methods also greatly multiply the rate at which money can be spent. These new opportunities for prospecting correspondingly enhance the importance of realistic estimates of the risk and probability factors.

It is obvious that statistical and probability considerations enter naturally and at once in most geophysical surveys. Whether the area for survey is only a few square miles as in many ground surveys or many thousand square miles as in large aerial surveys, the search (at least initially) is generally conducted over a regular grid in accordance with a preconceived plan. In any uniform search plan the average values discovered per unit area will obviously be determined only by the statistics of the distribution of targets, including of course the statistics of the pertinent characteristics of targets. Hence one should become interested in these statistics at the beginning of the planning stage. Much of this relevant information undoubtedly is well known and filed away, sometimes unconsciously, in the minds of experienced mining geologists. But there is need of more formal compilations, which would make available, in compact form, the growing fund of pertinent statistics being accumulated by mining companies, the government agencies, and individuals. A first need is estimates of mineral values in potential prospecting areas; and in particular, the values associated with targets of types now judged capable of discovery. The following two examples are illustrative of average mineral land values over large areas.

**Average Values in Mining Regions:** In a 650 square mile area in the southwest Wisconsin lead-zinc region, production up to the year 1955 was 590,000 short tons of lead and 1,110,000 short tons of zinc. At a price of $0.06 per pound for lead, and $0.05 for zinc, this is an average production of $280,000 per square mile. Since the area is estimated to be only about half explored, total ultimate production in this minor district may approach the surprisingly large figure of $400,000 to $600,000 per square mile. Prospecting in this area is done by the churn drill, and the probability considerations which determine optimum drilling plans have been analyzed[6] for this simple kind of prospecting operation.

Eight years ago, T. B. Nolan[7] pub-

lished an important study of a portion of the Basin and Range Province. In the area of about 125,000 square miles, within a 200-mile radius of Hoover Dam, there are 285 known mineral districts which have produced in all more than a billion dollars worth of gold, silver, copper, lead, and zinc. Two remarkable features of this production are: (1) its essential *uniformity* in the portions of the four states comprising the total area studied, and (2) the fact that "the areal distribution of the nearly 300 districts revealed no recognizable correlations with major geological features within the province." Nolan therefore drew the conclusion "that in very large areas, all within the same geologic province, a roughly constant amount of ore material has been introduced per unit area by the processes of mineralization". A point of special significance is the fact that *statistical uniformity* of the mineralization occurred over sub-areas which are *not* impossibly large in terms of airborne operations. These sub-areas, of size about 40,000 square miles and possibly less, could be surveyed at quarter-mile traverse spacings by two planes in two years.

In this total area of 125,000 square miles, between one half and two thirds of the area of potentially productive rocks is concealed by younger unproductive rocks and gravel-filled valleys. Thus, allowing for some future production from known mines, one may estimate that the total value in the five metals mentioned is about three billion dollars, or an average of $24,000 per square mile. The total value of the land in all minerals present, including other metals, non-metal deposits, construction materials, water, etc., clearly is far higher.

It is of interest that the few large districts produced almost all the metal. Of the 285 districts, the 11 largest, which produced over $10,000,000 each, accounted for about 85 percent of the production. Obviously these large districts represent the prime targets. Taking the larger estimate, about two thirds, for the portion of the area concealed by younger rocks, these large districts appear to occur at the very low average density of about one per 4000 square miles. This enormous area of barren land associated on average with each target—whether it be 4000 square miles per major district, as in Nolan's study, or only 400 square miles per ore body, as in parts of Canada, constitutes the major difficulty of the search problem. In the needle-in-the-haystack problem of finding blind ore bodies concealed in areas of hundreds or thousands of square miles, all the scientific clues which can lead to the eventual tracking down of the targets certainly require thorough study.

**Statistical Stability in Prospecting:** In Nolan's example it was noted that over large areas of about 40,000 square miles (and perhaps less), statistical uniformity occurred in the distribution of ore values. In the prospecting operations of a mining company, the hazards of long fortuitious runs of bad luck occasioned merely by normal statistical fluctuations can be avoided only by persisting in prospecting ventures on an adequate scale over the long term. For a mining company active in prospecting, a term of ten years may suffice for accumulating the amount of prospecting needed to achieve statistical equilibrium.

To illustrate the value of persistence as insurance against serious runs of bad luck, take the simple case of a company that continues its prospecting programs at about the same rate year by year, and let us assume that the chance of discovering a mine in any one year is 10 percent. Then a simple probability calculation shows that there is a 35 percent chance that no mine will be discovered after ten years of search; moreover there is a 10 percent chance that 22 years of effort will be rewarded with complete failure. Obviously management must be realistic about the possible effects of these perfectly normal statistical fluctuations upon the company's attitude towards prospecting. To achieve stability in the prospecting business, it is essential to adopt the philosophy of insurance companies, who spread their risks over a large number of ventures. An insurance business writing only a few dozen policies would certainly be a very risky business—and so is an exploration department which is not prepared over the long term to venture many times. Joint ventures provide a means for spreading the risks and achieving a more comprehensive and stable sample of prospecting experience for the given expenditure of funds.

**Statistical Evidence:** The decision to prospect for blind ore bodies with the aid of geophysics implies that a favorable estimate has been formed of the values capable of discovery. This forecast of the discovery expectations is based upon many specific considerations, but to an important degree the evaluation depends ultimately upon comparisons of the prospect area with other better known areas believed to be comparable in pertinent respects. Here the statistics of the occurrence of relevant geologic factors and of the distribution of pertinent characteristics of the targets enter as important considerations. Admittedly, when the exploration experts appraise the quality of the proposed venture, no formal marshalling of statistical data generally is evident. Nevertheless, the decision usually represents the judgment of experts who have been accumulating and analyzing prospecting information and probabilities, perhaps in part intuitively, most of their lives. Whether formally tabulated, or filed informally in the minds of the experts, statistical evidence is indeed the basis of these important prospecting decisions.

Now, it is well known that the validity of statistical evidence is high when the number of pertinent cases providing the evidence is *large;* but the reliability is low, when the number of cases is small. Accordingly it is clearly desirable that *large* compilations of statistics concerning relevant characteristics of targets in the various mining districts be produced and made available. The kind of information needed certainly depends upon the kinds of exploration tools available, and will change with changing styles in prospecting methods. To be specific, let us consider the two well known geological requirements for the success of the conventional electromagnetic prospecting method.

(1) The electrical conductivity of the ore body must be high relative to that of the overburden and country rock. With some minor exceptions, this usually means that the ore is massive iron pyrite carrying values in minor percentages of other sulphides. Unfortunately, however, other conducting rocks such as graphitic schists and barren pyrite bodies occur far more abundantly than do ore bodies. In Manitoba, it has been observed that non-commercial high conductivity conductors such as massive sulphides and graphites with good in-phase to out-of-phase ratios outnumber conducting ore bodies by a factor of 400 or 500 to one.[8] In other areas, ratios of 20 to 100 to one have been reported. It is clearly important to compile more complete statistics about the abundance of barren massive sulphides, graphite conductors and conducting ores in different mining regions.

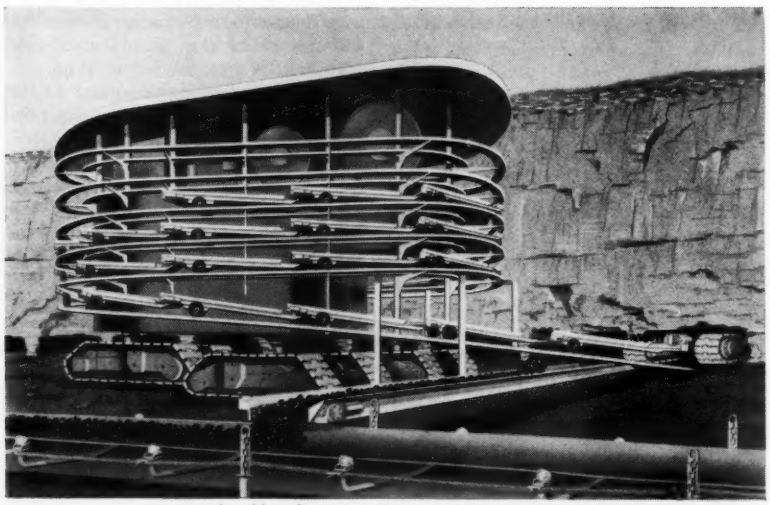
(2) Secondly, each of two dimensions of the ore body should in general be several times greater than the

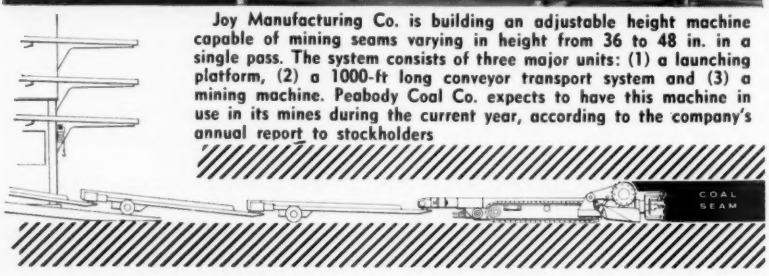
(*Continued on page 44*)

"The reduction in operating costs, realized by high production per manshift, good recovery and elimination of roof control, ventilation and drainage costs, makes the coal produced by this means (remotely-controlled mining system) competitive in cost with that produced by strip mining." The supervisor of design, construction, operation and maintenance of remotely-controlled mining machines for Union Carbide considers the past, present and future of a mining system that has excited the imagination of mining men everywhere

# REMOTE CONTROL IN HIGHWALL MINING

By
**J. W. HEIMASTER**
Union Carbide Corp.






Joy Manufacturing Co. is building an adjustable height machine capable of mining seams varying in height from 36 to 48 in. in a single pass. The system consists of three major units: (1) a launching platform, (2) a 1000-ft long conveyor transport system and (3) a mining machine. Peabody Coal Co. expects to have this machine in use in its mines during the current year, according to the company's annual report to stockholders

UNION Carbide has been interested in remotely-controlled mining since 1946. At that time, experiments were being made with the underground gasification of coal near Quick, W. Va. Two machines were built to make 36-in. diameter air passageways in the seam, the second machine being remotely-controlled. Although the company's experiments with underground gasification were discontinued, the remotely-controlled tunneling machine worked so well that it was decided to build a larger model.

Before the design of a third machine could be started, the problems associated with providing the operator with the necessary information regarding the location of the machine in the seam had to be resolved.

The major problem anticipated was in the design of a device to indicate to the operator the position of the machine with respect to the top and bottom of the seam, so that "rolls" could be followed without contaminating the coal with top or bottom material. It was also necessary to be able to follow the top and bottom closely, to get maximum recovery.

Other problems anticipated were associated with the need to keep the machine level crosswise, to avoid "spiralling"; to keep the holes straight and parallel, and at the proper spacing; and where the seam thickness would permit a double cut, the need to insure that the second cut followed the first without wandering.

## First Remotely-Controlled Mining Machine Points the Way

Once a solution to the above problems had been found, the design of a full-scale mining machine was begun. This machine went into operation in October 1949. It bored a roughly oval hole, 38-in. high and 116-in. wide. A second pass, below he first, recovered the coal in seams of greater height than 38 in. The cutting elements consisted of four overlapping cutter heads, driven at 60 rpm

through a speed reducer by two 60-hp motors in parallel. The cusps between the holes were removed by fixed blades at the top and bottom to produce an even floor and roof. Paddles were mounted on the outer two cutter heads, to direct the coal into the 40-in. wide central conveyor, which carried the coal to the rear of the machine. The entire front of the machine was shrouded, so that no coal could escape from the cutting area except through the conveyor.

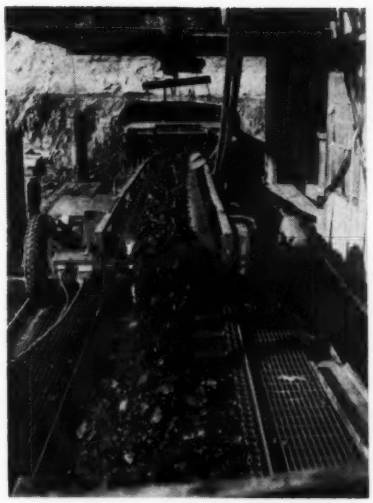
The machine was propelled on endless crawler tracks, powered by a 7½-hp variable speed d-c motor at 0-30 in. per minute for cutting, and a 20-hp constant speed a-c motor for tramming at 30 fpm.

The entire cutting assembly, consisting of cutter heads, scarfing blades, speed reducer and motors was pivoted at the front of the main frame. A hydraulic cylinder tilted this section, so that the machine could be steered up or down. One pivot could be moved a short distance vertically, to correct any tendency to spiral. Horizontal steering was accomplished by moving a pair of guide shoes mounted at the front of the machine, which bore against the sides of the hole.

A train of portable belt conveyors, each 30-ft long, and mounted on two rubber-tired wheels, was used to transport the coal from the miner to the surface. As the machine advanced, it pulled the train of conveyors after it, the length of the train being increased in 30-ft increments by adding a conveyor as needed, which operation required about 45 seconds. When retracting, the machine pushed the conveyors back out of the hole, and they were removed from the train as they emerged. This operation took an average time of three minutes per conveyor, because they had to be carried to the storage area individually.

A portable crane served to add or remove conveyors from the train.

Coal from the last conveyor in the train fell upon a flight conveyor in the floor of the launching platform, from where it was elevated to a truck-loading hopper. This platform positioned the machine to enter the coal seam at the proper elevation, and also housed the control station, cable reels, electric switchgear, etc. It was supported by four hydraulic jacks, which, when retracted, lowered the platform onto a set of rails upon which the platform, together with the machine, was moved from hole to hole. This operation normally took 30 minutes. When the jacks were extended, the rails were picked up by the platform. This permitted the rails to be positioned preparatory to the next move. Normally, a rib about 2½-ft thick was left between adjacent holes.



**Maximum depth of hole drilled with Union Carbide's first experimental machine was 690 ft, limited by the number of portable conveyors available. It was normally operated at a speed of two fpm, corresponding to about 2½ tpm. A portable crane added or removed conveyors from the train**

Several devices for obtaining the information needed by the operator in order to steer the machine were provided. A "stratascope," which basically is a device for measuring the cutting pressure on a cutter bit, was mounted on each of the outer two cutting heads. This pressure changed as the bit cut through the various layers in the seam. An electrical signal from each stratascope was shown on an oscilloscope screen, in the form of an irregular circular trace. The operator soon learned from the shape and location of these irregularities whether the seam was rising or dipping, and steered the machine to closely follow the top. This device also showed whether or not the second cut was following the first one. A radically different signal appeared if the machine got into the top or bottom. A pair of pendulums sent out electrical signals to show the inclination of the machine, both fore and aft and crosswise. An electric drill on the side of the machine was used to measure rib thickness. Each time the machine was stopped to add a conveyor, this drill was actuated. It drilled through the rib in about 40 seconds, and indicated to the operator the distance at which it broke out into the adjacent hole. A device at the hitch between the machine and the first conveyor of the train indicated the angle between the conveyor and the machine. By steering the machine to maintain the machine and conveyor in a straight line, a straight hole was assured.

Maximum depth of hole drilled with this machine was 690 ft, limited by the number of portable conveyors available. It was normally operated at a speed of two fpm, corresponding to about 2½ tpm.

The normal operating crew was three men, consisting of a machine operator, portable crane operator and a helper.

This experimental machine, while not a commercial success, pointed the way to the development of a practical system for mining by remote control.

### Improved Model Utilizes 800-Ft Long Continuous Conveyor Train

A new machine was built and went into operation in 1953. This machine bores the same size hole, but is heavier and more powerful than the previous model. The cutter heads are driven by a single 200-hp oil-cooled motor at a speed of 60 rpm. A rotary drum-type cutter is used to remove

**The company's second remotely-controlled mining machine is heavier and more powerful than the previous model. Note the rotary drum-type cutter used to remove the roof cusps. This permits the machine to climb more readily, and the power consumption is used as an additional indicator to tell when the machine is cutting into mine roof**

Conveyors (left) are assembled into an 800-ft train which follows the machine without stopping. "Minor" roof falls, up to 6-ft wide, 8–10 in. thick and 100-ft long, are caught and carried to the surface without incident on these 60-in. wide conveyors. Coal is discharged (below) from the conveyor train onto a cross conveyor in the floor of the control platform. This is done by reversing the direction of conveyor out by the transfer point, thereby reversing the coal flow. As the mining machine advances, the discharge point advances along the platform conveyor towards its forward end. Just before reaching this point, the succeeding conveyor is in a position to discharge onto the platform conveyor

the roof cusps. This not only permits the machine to climb more readily, but the power consumption of this cutter is an additional indication of contact with the top of the seam. The bottom cusps are removed by a fixed blade as before. This also is a fixed height machine.

Tracks are heavier and more rugged, and are driven by individual five-hp variable speed d-c motors at a speed up to six fpm. The same motors can be speeded up for tramming at 30 fpm. The individual drive to the tracks permits differential track speed for steering.

The machine is provided with two parallel conveyors, each powered by a 7½-hp a-c motor. These motors are reversible, so that if an oversize lump becomes jammed, the conveyors can be reversed, to discharge the lump back into the cutting area; where the cutter heads break it up.

A major improvement was made in the method of conveying the coal from the machine to the surface. Instead of stopping to add a section of belt conveyors as needed, the conveyors are assembled into a continuous train 800-ft long, which follows the machine without stopping. The train extends along the highwall when not in the bore hole. A center guide rail steers the wheels around a short radius bend associated with the platform, and along a wooden track laid on the road along the highwall. Power is supplied to the conveyor wheels by variable speed d-c motors, at a speed exactly matching that of the machine. This arrangement not only eliminates the time lost adding conveyors, but greatly reduces the time lost backing out of a bore hole rebitting, etc.

Because it is very difficult to convey coal around the short radius bend, the coal is discharged from the conveyor train onto a conveyor in the floor of the platform. This is done by reversing the direction of the coal flow so as to discharge from the front end of the conveyor which is on the platform. As the machine advances, this discharge point moves along the platform conveyor toward its forward end. Just before reaching this point, the succeeding conveyor is in a position to discharge onto the platform conveyor.

At this time, the operator flips a switch, the first conveyor reverses to carry the coal rearwardly, and the second conveyor starts, discharging the coal at its forward end. This process is repeated as each conveyor advances into the bore hole. A single switch reverses the first conveyor and starts the second in the proper direction. The conveyors do not operate unless they are carrying coal.

Another improvement was made in the conveyors themselves. Instead of 24-in. wide belt conveyors, these are 60-in. wide chain and flight conveyors. "Minor" roof falls, up to 6-ft wide, 8–10 in. thick and 100-ft long are caught by these wide conveyors, and carried to the surface without incident. This eleminates the need for men to go underground to clean up such falls, as was sometimes necessary with the older machine. Formerly, it was necessary to put up headers and props, go in and clean up these falls, then remove the timber before continuing the operation. Not only is a great deal of time and labor saved, but the hazards of men going underground are eliminated. With this new system, it is only necessary to go underground when the falls exceed 12 in. in thickness, which in this particular seam are rare. In fact, it is necessary for men to go underground not more than two or three times a year for any reason.

The conveyor train is designed as a huge chain, with a breaking strength of 50 tons, so that if the machine becomes fouled in the hole, a winch on the platform can pull it out. On only two occasions during the five years experience Union Carbide has had with this machine has the winch failed to dislodge it. In both instances a crawler chain had broken, and it was necessary to replace it before the machine could be withdrawn.

Instrumentation used on this model is similar to that used on the older model, but is greatly refined and made more rugged and reliable. In addition, some of the operations formerly done manually are now done automatically. For instance, automatic controllers now maintain the machine in a predetermined course at the desired angle to the horizontal, correct automatically for "spiral," and steer the machine to bore an absolutely straight hole.

The machine operator sits at a desk, watching the oscilloscopes which tell him where the machine is with respect to the top and bottom of the seam. He can look out the window and see the coal coming out on the conveyor train. In front of him are the oscilloscopes, with frequently used control buttons on each side. Above him are wattmeters, voltmeters, speed indicators, etc.

On the operator's right are the pushbuttons which control the main

motor, track motors, conveyor drive motors, etc. The entire system is interlocked so that if one conveyor stops, all conveyors preceding it stop, as well as the forward motion of the machine. This avoids spillage in the hole in the event of trouble, such as a conveyor chain breaking. Colored lights indicate whether motors are running or not.

To connect the control cables on the cable reels to the control station, four slip ring assemblies are used. One unit has 56 rings, another has 54, while the little ones have 14 and 8, respectively.

The hydraulic system which raises and lowers the platform so that the machine may enter the seam at the proper elevation is controlled by a battery of four-way valves, flow regulators, gauges and other equipment.

The reliability of this machine is such that it is now being operated 24 hours a day, seven days a week. Except for time out for such jobs as rebitting and moving to a new hole, the equipment, including the conveyor train, is ready to go 85 percent of the time.

Two operators are required, one to guide the machine, another to observe the operation of the conveyor train and to reverse the direction of a conveyor at the appropriate time.

Production records established by this machine are:

| | |
|---|---|
| Week (7 days) | 10,375 tons |
| Month (31 days) | 38,800 tons |

### Greatest Advantage is in Safety

The advantages of this system of mining over any other means of recovering coal from a highwall are many. The depth to which holes can be drilled is theoretically unlimited, but practical considerations probably will limit the depth to 1000–2000 ft. Because full seam height is recovered, the recovery realized is many times that achieved by augers.

Operation is truly continuous, because it is unnecessary to make "breakthroughs," no time is lost adding belt sections, waiting on shuttle cars is eliminated, etc. The only delay is for rebitting, which is unnecessary in many seams.

Because a hole is usually completed in 24 hours or less, weathering of the roof is negligible. This permits operation in seams with very tender roof. The wide conveyors adequately handle all minor falls.

No roof support of any kind is normally necessary because no men work underground. The same reasoning applies to ventilation.

Dust is no problem. The dust formed is heavy and damp, and settles quickly. With no air current present, the walls of the bore hole remain damp, so that the danger of dust explosions is minimized.

Drainage is not necessary because the machine is sufficiently waterproof to tram through any water likely to accumulate in a bore hole during the relatively short time required to complete it.

The greatest advantage, of course, is in safety. With no men working underground, the innumerable hazards associated with such work are eliminated. It is even safer than auger mining, since no heavy auger sections need be handled and coupled, and a substantial roof on the platform protects the working area from rocks falling from the highwall.

Another major advantage is the reduction in labor required. Only two men are required to mine and load into trucks an average of more than 400 tons of coal per shift, working in a 44 to 48-in. seam. This is many times the production per manshift achieved by other means of recovering coal from a seam of this thickness.

These men work outside the mine, where headroom is unlimited, ample light and air is always available, and where it is unnecessary to keep a constant watch upon their surroundings. The area is relatively quiet, so that communication between the workmen is simple and easy. All these factors contribute to efficiency and employee satisfaction with the job.

The reduction in operating costs, realized by the high production per manshift, the good recovery and the elimination of roof control, ventilation and drainage costs, makes the coal produced by this means competitive in cost with that produced by strip mining with huge power shovels, costing several millions of dollars each.

### Future—May Adapt System for Use Underground

An agreement has recently been made with Joy Manufacturing Co., granting them an exclusive license to build and sell remotely-controlled mining machines embodying Union Carbide's basic patents. Joy is currently redesigning the entire system for greater reliability, greater production, and decreased maintenance. Time studies are being made to improve the system for reducing the amount of nonproductive time.

Joy proposes to build an adjustable height machine capable of mining seams varying in height from 36 in. to 48 in. in a single pass. This machine will be about the same width as Union Carbide's present machine, but will have greater power to suit the increased height. All wearing parts will be in quickly replaceable unit subassemblies, to minimize down time for maintenance. Production is estimated to be about five tpm in 48-in. coal.

A 1000-ft long train of wide flight conveyors will be provided. The conveyors not in the bore hole will be stored on a helical runway surrounding the control center. This will keep them out of the mud and water in the strip pit, and will speed up the move from one hole to the next. The controlled curvature of the track will permit higher tramming speeds, making rebitting faster. A new system of discharging the coal from the train is being developed to simplify the wiring of the conveyor train. The machine runway is also a part of the helix, so that when the machine is out of the hole, all of the equipment is assembled in a compact package, easily moved upon the crawler tracks

**Control center for the entire operation. Sensing devices on the machine electronically report its actions to the operator through electrical signals which show on an oscilloscope screen in the form of an irregular circular trace. The operator then electronically guides the course of the machine by operating various push buttons and levers**

with which the platform is equipped.

The electrical system will be 100 percent a-c, to secure the advantages in reliability and low maintenance of squirrel cage motors. A system of telemetering is being developed, to transmit information to the operator with the minimum number of wires in the control cables.

The increased productivity of the machine, the decrease in down time due to greater reliability and easier maintenance, together with the ease of moving from one hole to the next with the compact helical storage track, should result in a system having an annual capacity of nearly a million tons of coal.

Serious consideration is also being given to adapting this system for use underground. One scheme suggested involves making a well-ventilated, well-protected gallery of sufficient width to serve as the operating area, and mining by remote control from both sides. The major problem, of course, is to "shrink" all of the equipment now used along the highwall to where it will fit into the gallery. Joy appreciates the advantages of an underground version of this system, and hopes to have such a system commercially available in about five years.

### Union Carbide's Role in Continued Development

Union Carbide has long been interested in cheap coal as a raw material for making chemicals, and intends to continue the development of this system to still further reduce the cost of coal. The company's work will probably consist of the development of rugged, more accurate instruments to supply the operator with more useful information, the development of automatic controls for the machine to minimize the effect of operator error, and advising and assisting Joy in the development of a commercial system, for both highwall and deep mining. Consideration is also being given to the design of a machine to recover the pillars between bore holes.

## MINING GEOPHYSICS

(*Continued from page 39*)

minimum depth of cover (for horizontal bodies only the horizontal dimension need be this large.) (a) Thus shallow cover is essential if small ore bodies are to be found; in fact the success of geophysical explorations is always critically related to the thickness of the overburden present. Probably much unpublished and inaccessible information exists based upon drilling, geophysical tests, and observations of outcrops which if compiled and published would provide useful information about the thickness of overburden in interesting regions. Indeed, in some areas it might be worthwhile to supplement existing information by further field studies of this point. (b) An adequate record is also needed concerning the depths at which discoveries have actually been made by e.m. methods. Apparently the vast majority of these discoveries are made at depths of less than 100 to 200 feet. (c) The distribution of massive sulphide bodies in respect to size or tonnage is a significant statistic in geophysical prospecting — especially in airborne operations where distances to ore are necessarily large. The success of airborne e.m. methods is strongly conditioned by the abundance of *large* targets. Rational planning of either airborne or e.m. surveys certainly would be promoted by the availability of compilations of the major dimensions and sizes of known massive sulphide ore bodies in the various mining districts.

**Competitive Aspects:** The more searching analysis of prospecting ventures, suggested here as a means of improving the efficiency of prospecting, clearly must be governed by the practical requirements of competitive prospecting. The company that sees the favorable opportunity early and acts promptly may achieve a major advantage over others who delay too long in improving their analyses of a situation. The competitive aspects of prospecting obviously add another interesting dimension to the range of considerations which should guide the decisions of management about prospecting ventures. One sometimes wonders whether these managers are being paid enough.

**Need for Research:** A final word about the need for research in the broad field of mining exploration — in geology, geochemistry, and geophysics. Admittedly progress in the basic sciences always aids, sooner or later, the development of the earth sciences. We have seen how quickly the studies in nuclear magnetic resonance led to a new type of field magnetometer. But there is also need of research addressed more definitely to fundamental problems in mining exploration. In the many research laboratories of the petroleum industry it has been shown that research directed to exploration is highly productive of practical prospecting benefits.

Unfortunately, the amount of research activity in mining exploration is small relative to the scope and challenge of this field. Relatively few research scientists are devoting their major efforts to problems of mining exploration. Eliminating the geologists and geophysicists who are engaged in practical exploration, in business and administrative duties, and in other non-research activities, it seems clear that fewer than a hundred scientists in this country are essentially full-time researchers in mining exploration. It is certain that much could be accomplished by increasing the number of highly qualified scientists fully engaged in research in this broad field. Since this number is now so small, it would be easy to double the total effort.

The case for such research rests on three elementary propositions about the supply, the need, and the chances of discovery of needed metals in this country.

(1) There are large quantities of undiscovered ore concealed by only a few hundred feet or less of overburden.

(2) Despite short term depressions in the metal market, the trend of world consumption of metals, decade by decade, is rapidly up. We shall soon need the large undiscovered tonnages of many of the important industrial metals.

(3) The best chance of finding these metals will come from the knowledge and skills which are achieved through research.

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# MINING By hydraulic jet

**No blasting, loading or tramming → LESS COST**

**Simple and dustless operations → GREATER SAFETY**

By

**J. H. BAKER**

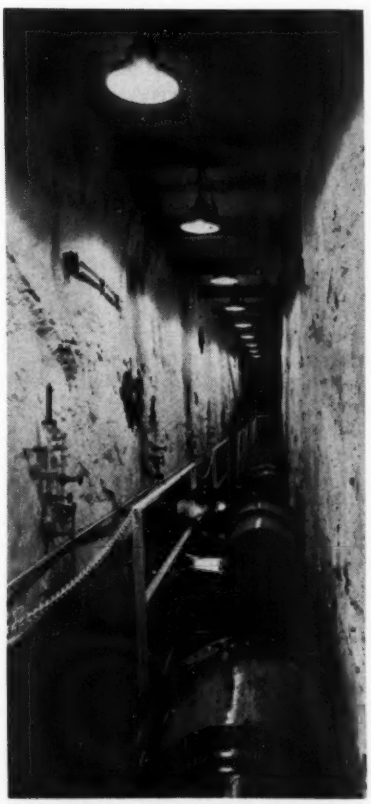
**Assistant Production Manager**
**American Gilsonite Co.**

AMERICAN Gilsonite Company's proposed mining method was described in the August 1956 issue of *Mining Congress Journal*, prior to the actual start of operations. The company has now been in operation for 26 months, and the author is happy to report that the company's system of hydraulic mining has worked out, with minor modifications, as well or better than was predicted. This, in a period of rising labor and material costs, has been most gratifying.

"Gilsonite" is a solid hydrocarbon which occurs in vertical fissures that cut the sandstone and shale beds of the Uintah formation in southeastern Utah. It is found in other parts of the world under similar occurrence, but nowhere else is it now being mined commercially.

The Gilsonite veins on entering the shale members of the Green River formation break into small veinlets separated by shale. These veinlets are not now economical to mine.

The veins strike northwest-southeast through the basin while the sandstone beds dip northwest at about 2½ degrees. Since the Green River shales outcrop in the eastern end of the area and dip westerly, the workable portions of the veins vary from a few feet to 1500 ft in depth. The veins vary from a few inches to 22 ft in width and tend to narrow with depth.



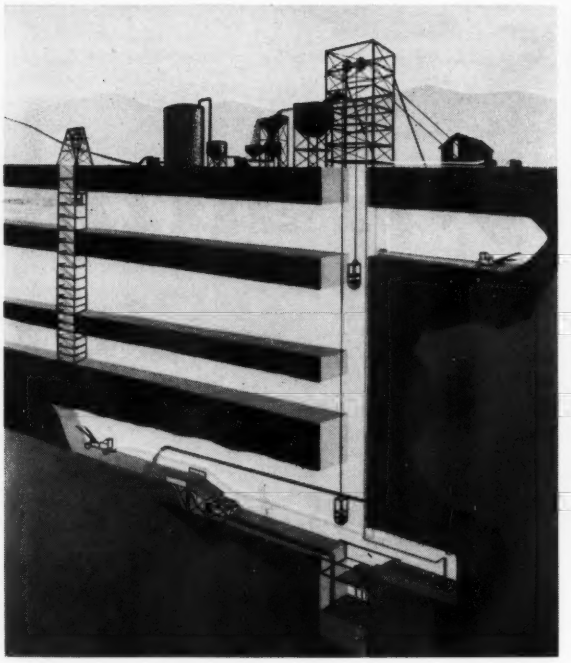
Five horizontal centrifugal pumps in series lift the ore 800 ft vertically to the surface slurry preparation plant

### Soft Ore Created Dust Problem

Gilsonite is brown, but has a black luster with a conchoidal fracture. It has a hardness of 2 and a specific gravity of 1.05. It is brittle at normal temperatures, but softens above 275°F. It has sometimes been referred to as solidified or petrified petroleum.

Although Gilsonite is quite soft, it is compressed very tightly between the sandstone walls. The miners learned early that a narrow trench along one wall to a depth of two ft would relieve the pressure on the remaining portion of the vein and allow it to be readily removed.

In the past the following techniques have been used in breaking Gilsonite: hand and pneumatic picking, Cardox blasting, air blasting, and blasting with permissible dynamite. To give you a general idea of the resistance of Gilsonite to removal, it requires one lb of 50 percent strength powder in an eight-ft vein to break two tons of Gilsonite.



Artist's conception of American Gilsonite's operation

Each air-powered, track type vehicle mounts two jet cutters. The cutters consist primarily of two pipes which are fitted with ¼-in. nozzles; and pass 82 gpm at 2000 psi and a velocity of 360 mph. Gilsonite is cut loose and flushed away at an average rate of 50 to 60 tph.

None of the foregoing methods were considered successful due to the large quantity of dust created in the breaking operation, and due to the disastrous effect of the explosions caused by ignition of the dust.

With the advent of hydraulic jet cutting, these problems were to a great extent overcome.

When Gilsonite is mined dry and pumped to the surface slurry preparation plant, it creates an intolerable amount of dust in the plant. Not so with the jet-mined ore. This gives evidence that the water has been well wiped onto the surface of the Gilsonite particle as well as into any fracture planes which may not be visible to the eye.

Russian papers, which have been translated and brought to the company's attention recently, indicate that they have been using water jets to mine and assist in the mining of coal for some 15 or 20 years. While considerable information has been obtained from these articles, it is felt that AGC's experiments might have failed had the company's staff read these articles prior to their first attempt at jet cutting in 1948.

Russian practice was based on low pressure (700 psi maximum) and large volume. This was dictated by the fact that high pressure pumps and piping were not available to them. Our initial attempt at hydraulic jet cutting was at 1600 psi water pressure, and while not successful, the attempt gave indications that possibly 2000 psi might be successful.

In 1954 experiments were conducted using pressures up to 2300 psi. These showed enough promise to serve as the basis for design and operation of the present system.

### Track-Mounted Hydraulic Jets Break Up Gilsonite

In 1956 a jeep chassis was outfitted with hydraulic booms and nozzles to be used as the vehicle to transport the cutting equipment and the operators. It was soon found that the jeep did not possess sufficient mobility to serve this purpose. The next design included a track type vehicle sufficiently small to operate within verticle walls six ft apart. This unit is easily assembled and disassembled for moving from one location to another within the mine. The power for this vehicle is furnished by an air motor.

The booms are made up of pipe — the upper pipe carries the high pressure water and has the nozzle attached for the cutting operation. Normally a ¼-in. nozzle is used which passes 82 gpm at 2000 psi and delivers water to the ore at a velocity of six miles per minute. Water with this velocity is forced into the fracture planes in the ore, and between the ore and the rock, where the energy is expended. The lower pipe is used to carry low pressure water to the face for fluming the ore to the receiving pocket. Approximately 350 gpm of water is carried in the fluming line for each jet. The cutting rate per jet is normally between 25 and 30 tph or 50 to 60 tph per car. Rates of 100 tph per car have been obtained. This is 200 cu yds of broken ore per hour.

Two operators are required per car, each has control over one boom.

The cutter car is attached to the water and air systems by means of hoses. The high pressure hose is 1½ in. in diameter and the low pressure hose is 3 in. in diameter. Normally 150 ft of hose is used off each pipe outlet spaced at 250 ft in the stope. Three-in. high pressure schedule 80 pipe is installed in the entry under each pillar. At 250-ft intervals, pipes and manways are carried downward to within 20 ft of the floor. Valves are installed at each takeoff tee and at the end of the pipe. Hoses are left attached to the pipeline and, when moving the car beyond the range of the hoses, they are disconnected from the car and the set from the forward line is attached.

Stoping is by underhand methods by advancing a 10 to 12-ft high bench the full length of the stope — which will vary from 1000 to 1500 ft. The stope floor is carried upward on a five percent grade to assist the fluming. Floors, timbering and bolting are kept parallel to this grade. Three by 10-in. by 10-ft planks are installed parallel to the stope floor by roof bolts on 8-ft centers. Two-in. blocks placed under these planks, at the bolts, permit lagging to be installed behind the planks where the wall conditions

*(Continued on page 52)*

## PART I:

# The Dutch State Mines Heavy Medium Cyclone Washing System

**European coal producers have found heavy medium cyclone washing of fine coal to be practical. Fines can be cleaned at any specific gravity from 1.30 on up and, at the same time, an extremely sharp separation can be made at any gravity required**

By

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HEAVY medium washers for the treatment of nut size and large coal are well-introduced in this country. These systems are now recognized as well-working systems with high efficiency at reasonable costs. The use of magnetite as a heavy medium is quite common; magnetic recovery of this medium is giving satisfaction and limited medium losses.

One must realize, however, that heavy medium systems for *small* coal entail very special problems regarding the efficiency of the separation as well as with regard to the regeneration of the magnetite.

The difficulties concerning the efficiency of the separation for small size coal are solved by the cyclone washer, the subject of this article.

### Allen Law—Falling Velocity of Particles in a Suspension

Let us start by considering the falling velocity of a particle in a suspension. This velocity decreases rapidly as the size of the coal becomes smaller, which can be seen from the law of fall for coal and shale particles of slack size.

For such particles the Allen Law has to be applied:

$$v = A \left( \frac{4\ g}{30\ \gamma_s \sqrt{\upsilon}} \right)^{2/3} d\ (\gamma_k - \gamma_s)^{2/3}$$

in which:

v = falling velocity of the particles
g = gravitational acceleration
$\upsilon$ = kinematic viscosity $\left( = \frac{\eta}{\gamma} \right)$
d = particle diameter
$\gamma_s$ = specific gravity of the suspension
$\gamma_k$ = specific gravity of the particle
A = shape coefficient, for coal and shale particles approximately 0.5.

Dutch State Mines' research work on coal preparation is carried out in this building of the Mining Research Establishment

If both d and $(\gamma_k - \gamma_s)$ are small, the falling velocity is much reduced. It can be raised by reducing the viscosity of the medium, but this can only be done to a certain limiting value by increasing the size of the recovery section of the heavy medium system so that pure magnetite medium is obtained.

Not only the efficiency but also the capacity of a normal type of sink-and-float washer decreases rapidly as the size of the coal becomes smaller because of the same reason.

So far some sink-and-float heavy medium plants are known which handle coal down to two–three mm, but only on a limited scale, and at low densities.

Major improvements can only be obtained by increasing the value g; in other words, by replacing the gravitational acceleration by centrifugal action. This has been realized in the cyclone washer, where centrifugal acceleration is about 20 times the gravitational acceleration.

Thus, the falling velocity is increased considerably and the separation takes place in a short period of time.

Moreover, the vicosity is no longer of such vital importance, so that the suspension used in a cyclone washer can be dirtier than is necessary in normal sink-and-float processes, which simplifies the regeneration system.

The question of accurate separation for small coal being thus solved with the aid of the cyclone washer, the complication in the regeneration system did require further attention.

One must realize that in heavy medium separation all the particles to be separated have been in contact with the heavy medium. The normal way of further handling of the products is to dewater them over perforated screens in order to get rid of most of the suspension which leaves the separator together with the washed products. After this procedure, the washed products are rinsed with water in order to clean the surface of the products—also normally done on the screens.

First of all, when slack size coal is treated, such dewatering and rinsing have to take place on a fine mesh screen, say e.g. 35 mesh with small open screening area. Thus, a far more difficult dewatering and rinsing job has to be done, requiring a much larger screen area than for larger size coal.

Furthermore, the quantity of adhering suspension on the products is inversely proportional to the average diameter of the product. For slack size coal this average diameter is ten times or more smaller than for nut size coal, the adhering suspension being 10 times or more greater. Generally speaking, it may be said that for a given regeneration system the losses of medium are proportional to the total amount of adhering suspension.

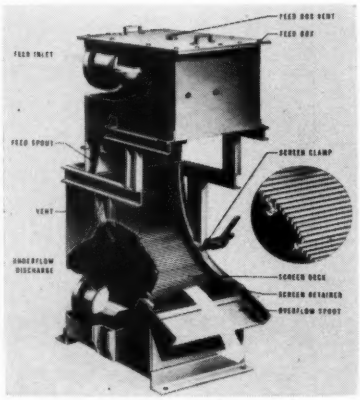


**Fig. 1. The sieve-bend is a curved stationary slotted screen**

Moreover the necessary amount of rinsing water has to be increased for smaller size coal.

From this it will be clear that much attention has to be paid to the heavy medium regeneration system, both in regard to total required equipment, and to magnetite losses.

## Regeneration System of Cyclone Washer

There are four main items in the regeneration system; pumps, screens, thickener and magnetic separators.

Of these items, the pumps are the least expensive.

Thickeners are usually not so expensive, but are a nuisance. If they are accommodated within the washery, the costs of the building are high, but if they are built outside, much piping and extra pumping are required. It is therefore essential to eliminate the thickener or at least to reduce its size.

The most expensive parts are the screens and the magnetic separators. As regards screens, the development of a new screening tool has greatly improved the heavy medium cyclone washer system.

## Dutch State Mines Sieve-Bend

In trying to solve the problems connected with washing and thickening, centrifugal forces are used as pointed out above. An analogous development can be observed in our search for ways of screening at fine meshes large amounts of liquid containing fine and coarse particles. This led to the designing of the sieve-bend by Fontein[1,5].

The sieve-bend (figure 1) is a curved stationary slotted screen. It is fed from a supply tank, the material being fed tangentially onto the screen at a certain rate. Slots are perpendicular to the direction of the flow of the liquid. In choosing the slot width one should bear in mind that the cut is made at a particle diameter equal to half the slot width. If the cut is to be made at 0.5 mm, one-mm slots have to be employed.

Fontein's explanation of this phenomenon may be summarized as follows (figure 2).

The layer of the mixture of water and solid material moving across the screen gets thinner after every slot, as a certain amount of liquid is discharged through the slots. The thickness of the layer that is "shaved off" appears to be about one-fourth of the slot width. This thickness is not dependent on the curvature of the screen, but is bound up with the fact that, when the friction against the

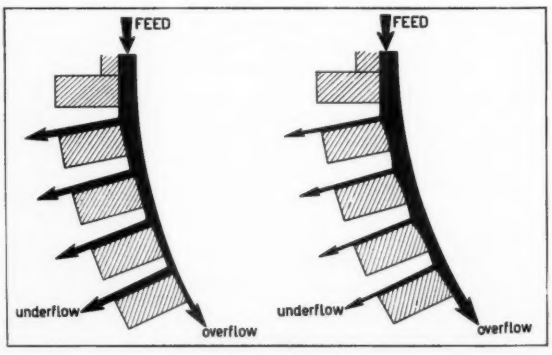


**Fig. 2. Left—sieve-bend with new bar sieve; right—sieve-bend with worn bar sieve. When the sieve-bend wears away, the diameter at which the cut is made becomes smaller and, at the same time, the capacity of the sieve-bend decreases. By turning the screen in such a way that the feed end becomes the delivery end, the diameter of separation becomes larger again and the capacity is raised. Consequently, the screen must be turned at regular intervals**

dam disappears, the stream of water is deflected.

If now, supposing one-mm slots are used, a particle with a diameter smaller than 0.5 mm collides against the following dam, it is discharged along with the water. If, however, such a particle is larger than 0.5 mm, more than half of it will project above the dam, so that it skips over. This explains why 1-mm slots have to be used for making a cut at 0.5 mm.

This fact gives the sieve-bend a very important advantage over other types of screens, because, owing to the absence of blockages, its capacity is enormous. With normal vibrating screens there is always the chance that, when fine-grained materials are being screened, the cloth or the slots will be partly blocked. As a result the capacity of such a screen decreases considerably.

If a fine-grained material containing a high proportion of particles with diameters somewhere near the mesh width is being screened, blockage may become serious. With the sieve-bend this problem is much less serious, because here the slots are twice as wide as the particle diameter at which the separation is made. Naturally, another great advantage of the sieve-bend is that it is stationary, so that its operation is much cheaper than that of a vibrating screen.

The screening capacity per unit of surface (10.8 sq ft) of screening deck is between 10 and 100 times as large for a sieve-bend as for a vibrating screen. In addition, screening at a very fine mesh under plant conditions becomes possible, whereas with vibrating screens this could never be achieved.

When the sieve-bend wears away, the diameter at which the cut is made does not increase as it does with a normal moving screen, but, on the contrary, becomes smaller. Figure 2 shows this clearly. At the same time the capacity of the sieve-bend decreases.

By turning the screen in such a way that the feed end becomes the delivery end, the diameter of separation becomes larger again and the capacity is raised. Consequently, the screen must be turned at regular intervals.

Screens in normal use in coal washeries are turned once or twice a week. To give you some idea of the loads that may be applied, it can be stated that a sieve-bend with a width of one m (3.3 ft) making a cut at 0.5 mm has a capacity of some 150 cu m/hour (0.666 U.S. gpm).

In general the capacity of a sieve-bend may be determined by using

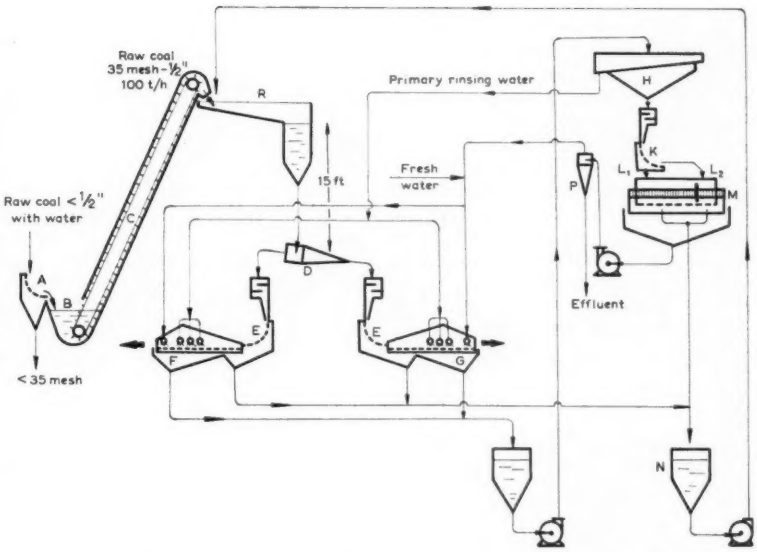


**Fig. 3. Flowsheet of a modern cyclone washer system for raw coal (35 mesh by ½ in.): A = Sieve-bend; B = Sump; C = Bucket elevator; D = Two 20-in. low-pressure cyclone washers; E = Sieve-bend; F = Rinsing screen; G = Rinsing screen; H = Thickener; K = Sieve-bend; M = Magnetic-separator; N = Tank; P = Cyclone thickener; R = Feed tank**

the following rule-of-thumb:

$$C = 200\,FV$$

where: C = capacity in cu m per hour,
F = free screening area in sq m (area of slots),
V = rate, in m per sec.

The diameter of separation is independent of the rate of travel and practically independent of the concentration.

Sharpness of separation compares with that of a normal moving screen.

The only inconvenience of the sieve-bend is that the overflow of the screen does contain a higher percentage of water than the oversize of a normal vibrating screen. Generally speaking, the oversize still contains about 40–60 percent by volume of water.

From what has been pointed out above, it will be clear that the sieve-bend is an important tool in the regeneration system of the cyclone washery, a description of which is given below (see also reference 6).

## 100 TPH Cyclone Washer Plant (35 Mesh by ½ In.)

The flowsheet of a modern cyclone washer plant is schematically shown in figure 3. Raw feed has to be deslimed at 35 mesh. This is done with the aid of sieve-bend A. The oversize still containing too much water is fed into a little sump B from where it is dragged to the top of the building with the aid of a bucket elevator C.

The plus 35 mesh deslimed product (100 tph) is then fed from the feed tank R by gravity, together with the magnetite suspension, into two 20-in. low-pressure cyclone washers D, which are placed in an almost horizontal position. The required pressure is 15 ft static height.

The washed products are then dewatered, first over sieve-bends E on which the bulk of the suspension is extracted from the washed products. The clean coal is fed to one 8 by 16 ft screen F, the sinks to one 4 by 16 ft screen G. Only a small part of these screens is used for further draining, the rest being used to rinse off the adhering suspension.

By placing the sieve-bends ahead of the screen, the total required screen area has been reduced considerably. Before the sieve-bends were in operation, two more vibrating screens were required for draining the products. A considerable saving has been obtained, both here and in the desliming system, through replacing vibrating screens by the sieve-bend.

The sieve-bends have one-mm slots; the screens, 35-mesh wedge wire screen decks.

As has been pointed out before, the amount of rinsing water required to clean the products is large. All this rinsing water has to be clarified and the magnetite which it contains has to be recovered.

In large coal sink-and-float washeries, all the rinsing water is generally fed to magnetic separators. This would necessitate for a cyclone washer the use of a great deal of mag-

netic equipment, which is expensive. An alternative could be to send all the rinsing water to a thickener, of which only the underflow was sent to magnetic separators, while the overflow is used for rinsing the products.

It was realized that this thickener or settling cone could be kept small when the overflow was only used for the purpose of primary rinsing. In our case a 14-ft diameter cone H is sufficient to clarify the rinsing water (taking advantage of the magnetization of the magnetite particles). The overflow still contains 3–5 gram per liter of magnetite; however, for primary rinsing water, this is sufficiently low.

The underflow from the settling cone, containing most of the magnetite and coarser coal particles (coming into the system due to inefficient screening), together with about one-third of the water, is sent to a sieve-bend K with 0.3 mm (50 mesh) slot width.

Underflow from this sieve-bend, which contains most of the magnetite, is fed to one part $L_1$ of a drum type magnetic separator M. The overflow of the sieve-bend is fed to the other part $L_2$ of the three-ft wide magnetic separator.

Overflow contains most of the coarser non-magnetic particles and only a small amount of magnetite, so that the magnetite suspension coming from part $L_2$ of the separator is not as pure and as high in density as that from part $L_1$. The magnetite suspension from part $L_1$ is fed into the tank N from where it is recirculated to the raw coal feed tank R. The magnetite suspension from part $L_2$ is either fed into the dilute medium system, in case a very pure and high density is essential, or sometimes also into the tank N.

Even in the last case the use of the sieve-bend ahead of the separator is important, as it was found from experiments that feeding dilute magnetite suspension directly to the magnetic separator without passing the sieve-bend gives a dirtier magnetite from the separator than the mixture coming from $L_1$ and $L_2$ in the first case.

The explanation for this is probably that magnetic particles are forming nets round the non-magnetic particles, causing the non-magnetics to be gathered by the separator together with the magnetite. Without the use of a sieve-bend there is much more chance for a coarse non-magnetic particle to be gathered, so that the magnetite coming from the separator becomes dirtier.

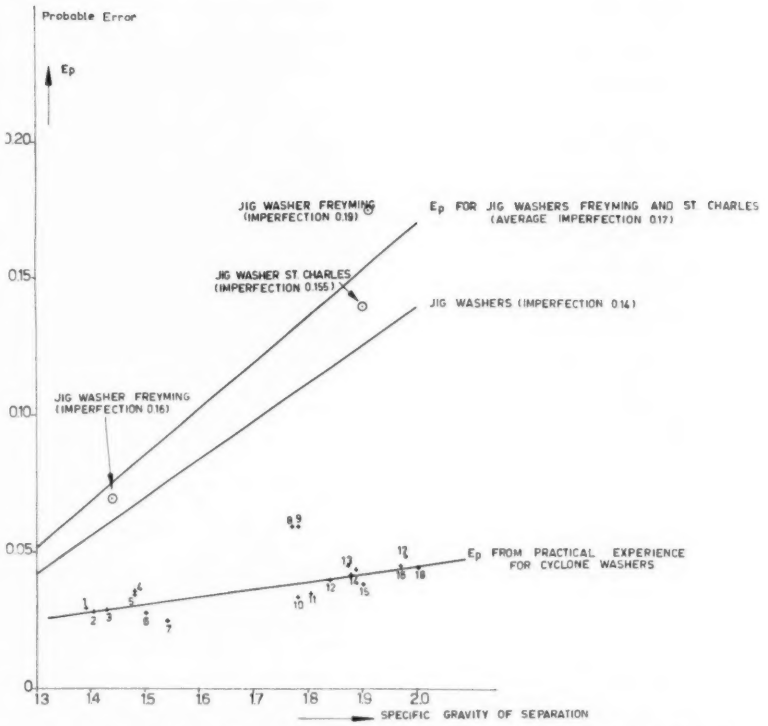


**Fig. 4. Comparison between jig washer and cyclone washer for 0.5 by 10 mm coal**

Efficiency, even for the fine size magnetite (grade B*) used for the cyclone washer, is high for the modern magnetic separator, namely up to 99.6 percent.

Density of the purified magnetite suspension is high, so that no densifier is required and the magnetite can be fed straight back into the heavy medium circuit.

The water with the non-magnetic particles is fed to a cyclone thickener P. Overflow from this cyclone is used for secondary rinsing together with some fresh water. The underflow is bled off.

As compared with the original cyclone washer the required equipment is reduced considerably. The high pressure vertical cyclone formerly used is now replaced by the low pressure horizontal cyclone, thus reducing both the height of the building and power consumption.

The number of vibrating screens for draining and rinsing has been halved.

Desliming ahead of the cyclone washer is now done without any vibrating screens. A much smaller thickener is used and the magnetic equipment has been reduced due to the high efficiency of the modern drum type separator, making a secondary magnetic separator unnecessary. A densifier is no longer required. The density obtained from the magnetic separator is sufficiently high; the magnetite is also pure due to the installation of a sieve-bend ahead of the separator.

* 92–95 percent minus 325 Tyler mesh.

## European Experience with Cyclone Washers

So far 16 cyclone washing plants are in operation in seven different countries of Europe, the total capacity being 1400 tph (table I). Ten more plants are under construction in Belgium, Rhodesia, South Africa, Brazil, Czechoslovakia and Germany with a total capacity of about 1500 tph. All these plants are built under license of the Dutch State Mines' patents and in close contact with its specialists.

*Washing results* of the cyclone washers in operation are obtained from large-scale tests by independent institutes—e.g., the Cerchar (Centre d'Etude et de Recherche de Charbonnage de France), the Inichar (Institute National de l'Industrie Charbonnière de Belgique) and the National Coal Board in England.

As is common now in Europe, the

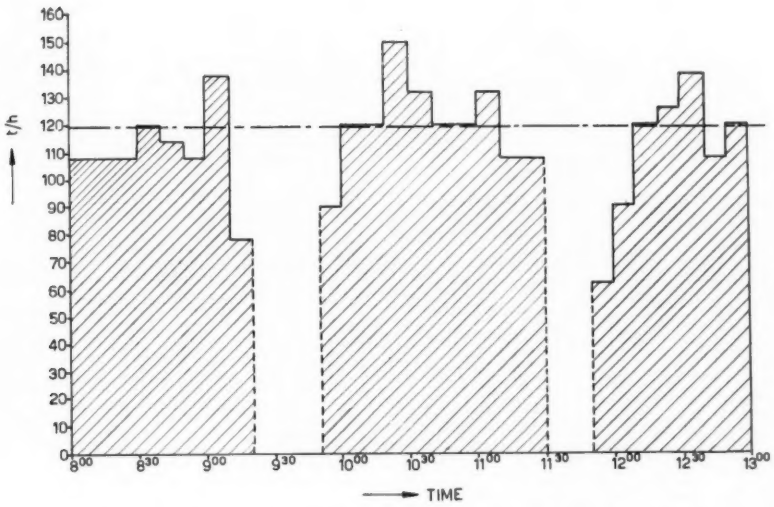


**Fig. 5. Washery "La-Houve." Capacity in tons per hour for 2 by 10 mm grain size as a function of the time for the feed to the cyclone washers. Test was carried out by Cerchar, June 14, 1955**

washing results are expressed in "écart probable" (probable error) f,[8]. As a matter of interest, figure 4 compares the results obtained with these cyclone washers to those obtained with modern jig washeries, as published by Belugou, Daniel and Pozzetto in their paper, presented before the recent International Coal Preparation Conference at Liège.[9]

The washing results are obtained from practical plant operations, while the variations in loads of the washery concerned are very great.

As an example, the variations in load of the cyclone washery la Houve are shown in figure 5.[10] One of the great advantages of the cyclone washeries, as compared with other types of washeries, is that the results are practically independent of these variations.

Apart from providing washing results expressed in "écart probable," a figure not yet commonly used in the United States, this article will give some of the results obtained at the Dutch State Mines' cyclone washeries in more practical figures.

At the Wilhelmina washery (daily production of about 6500 tpd run-of-mine coal) the cyclone washer now in operation has replaced an old Rheolaveur washery. The Rheolaveur was making only two products, clean coal and shale. The cyclone washer is making three products: clean coal, middlings and shale.

The clean coal produced by the cyclone washer is low in ash, as the coal has to be used for special purposes. Adding the middlings to the clean coal gives a product with an ash content about equal to that of the clean coal of the Rheolaveur.

Table I

Cyclone washeries for coal in "operation"

| Name | Country | Actual feed tph | Grain size in mm |
|---|---|---|---|
| Ressaix | Belgium | 136 | 0.75–8 |
| Rieu du Coeur | Belgium | 95 | 0.5–10 |
| Winterslag | Belgium | 200 | 0.5–10 |
| Anderlues | Belgium | 45 | 0.3–12 |
| Victoria-Lünen | Germany | 30 | 0.5–10 |
| Bonifacius | Germany | 44 | 0.5– 8 |
| Germania | Germany | 60 | 0.5–10 |
| Graf Moltke | Germany | 20 | 0.5–19 |
| La Houve | France | 200 | 0.5–10 |
| Ste. Barbe | Saar | 77 | 0.5–10 |
| Nine Mile Point | Great-Britain | 85 | 0.5–10 |
| Hendrik | The Netherlands | 125 | 0.5–19 |
| Emma | The Netherlands | 40 | 0.5–13 |
| Emma | The Netherlands | 50 | 6–16 |
| Wilhelmina | The Netherlands | 160 | 0.5– 6 |
| Kakanj | Yugoslavia | 45 | 0.5–10 |

Table II

Losses in refuse

| | Rheolaveur washery % | New cyclone washery % | Savings per year guilders |
|---|---|---|---|
| < 1.45 sp gr | 4 | 0.2 | 300.000 |
| < 2.2 sp gr | 27.7 | 6.6 | 1000.000 |
| % ash fraction < 2.2 sp gr | 35.2 | 52.2 | |

As can be seen from table II, the refuse of the Rheolaveur did contain four percent of product, less than 1.45 specific gravity, and the refuse of the cyclone washer only 0.2 percent.

So, for this colliery the total available saleable slack-size coal was increased by about 17 tpd. For a price at the pit of 57 guilders per ton (about $15 U.S.) this amounts to about 300,000 guilders per year.[2]

Apart from the real coal, a large amount of middlings was lost in the shale. The refuse of the Rheolaveur contained 27.7 percent of a product with a specific gravity below 2.2 with 35.2 percent ash. For the refuse of the cyclone washer this was only 6.6 percent with 52.2 percent ash. This middlings product, which is valuable for the power station, is evaluated according to ash content. For Wilhelmina Colliery this decrease of losses in the refuse results in a saving of about 1,000,000 guilders per year.

In one of the other Dutch State Mines' washeries, the Hendrik washery (daily production of about 8400 tpd run-of-mine coal), a cyclone washery was installed to re-treat the middlings product of an existing jig type washer. Originally this was done by a jig re-washer. The washery delivers three products: clean coal, middlings and shale. As a result of the introduction of the cyclone washer, the output of saleable coking coal was increased by 510 tpd. The production of middlings was reduced by 600 tpd, which was helpful as there was an overproduction of middlings for the power station.

The *magnetite losses* obtained during long periods of operation are given in table III. This shows that the losses of magnetite for the cyclone washeries handling a product below ten mm are close to 500 grams per ton. For smaller size coal they increase slightly, but remain within reasonable figures.

Table III

| | | Grain size mm | Magnetite losses kg/ton feed |
|---|---|---|---|
| La Houve | France | 0.5–10 | 0.500 |
| Ressaix | Belgium | 0.5– 8 | 0.700 |
| Emma | The Netherlands | 0.5–13 | 0.500 |
| Hendrik | The Netherlands | 0.5–19 | 0.600 |
| Wilhelmina | The Netherlands | 0.5– 6 | 0.700 |
| Rieu du Coeur | Belgium | 0.5–10 | 0.300 |

[2] The official rate of exchange: $1 U.S. = 3.85 guilders.

### Power and Maintenance

The total power required for one of the newest cyclone washers making three products, namely the one at Wilhelmina Colliery, including the desliming system and the recovery of the magnetite, is 4.8 hp per ton of feed.

As stated above, the magnetite used is fine (grade B). A great advantage is that the wear of all moving parts, such as the pumps and pipelines, is much less with fine than with coarser magnetite.

By using the proper material, wear can be kept within very reasonable figures. The use of special white cast iron for the hydrocyclones has increased the lifetime to one year or more. The impellors of the medium pumps have a lifetime of 2200 hours.

Velocity in the pipelines should not exceed a certain limit in order to reduce wear. Special care has to be taken of curves and turning points in the pipelines. However, a properly-designed plant does not give rise to complaints about wear.

### Automatic Control

Control of the medium density is completely automatic. The medium can be kept constant, within a range of 0.003 in density. This constant gravity is of great value for obtaining an accurate separation, which will result in a constant ash content of the washed coal.

### Sizes Treated

The cyclone used in a cyclone washery generally has a diameter of 500 mm (20 in.), a feed opening of 100 mm (4 in.) an overflow opening of 215 mm (8½ in.) and an underflow opening of 150 mm (6 in.). There is a practical rule that the maximum size of particles passing through an opening should never exceed one-third of such an opening. From this it will be clear that from a point of view of blockage the maximum size of coal that can be treated in a 500-mm cyclone will be 33 mm (1 5/16 in.).

Choice of this maximum size will depend in many cases on the market requirements.

For instance, if 25 mm (1 in.) is a market size and the nut-size coal washery is already highly loaded, one may consider handling the minus 25 mm (1 in.) size in a cyclone washery.

In western Europe ten mm is very often a market size, so that there the maximum size treated in cyclone washeries is usually ten mm.

A 10-mm particle still has a reasonable falling velocity under the influence of gravitational acceleration, so that a static sink-and-float washer can be used with reasonable capacity and accuracy down to this size.

For smaller sizes there is a definite advantage for the cyclone washery over gravitational sink-and-float processes.

So far the maximum size of coal actually treated in a cyclone washer has been 19 mm; however, one plant is under construction which will treat raw coal up to 31 mm in size.

**Next month *Mining Congress Journal* will present the second and final part of "The Dutch State Mines Heavy Medium Cyclone Washing System," which will consider examples of typical American coal and predict results which can be obtained in a heavy medium cyclone washer.**

## MINING BY HYDRAULIC JET

**By J. H. Baker**

(*Continued from page 45*)

require lagging. Stulls are placed across the vein and are supported by the three-in. planks at 48-ft vertical intervals. Here, the company tries to wooden center strip is installed on the stulls for pneumatic-tired timber trucks to use as a roadway. This floor provides entry for supplies and protection from falling rock. Pillars slightly deeper than the width of the vein are left at 250 to 300 ft vertical intervals. Here, the company tries to pick an offset or a weak strata of rock in which to leave the pillar. Drifts under these pillars are driven by hand operated jets pivoted on a pneumatic bar.

The broken ore and the flume water move by gravity to a screen which passes the plus ¾-in. material to a crusher, and thence into the sump. The ore and water are mechanically agitated in the sump where a deep well pump takes suction and discharges into the suction of five horizontal centrifugal pumps in series. These pumps lift the ore 800 ft vertically to the slurry preparation plant located on the surface.

### Slurry is Pumped 72 Miles

In the preparation plant, the ore is passed over a dewatering and sizing screen and the maximum size particles are reduced to minus ⅛-in. Water is then again added to the ore to obtain a 40 percent by weight solids concentration for pumping to Gilsonite, Colo., 72 miles south of the mine. After cleaning in hydroclones, the excess water is returned to the mine for fluming more ore to the sump.

The high pressure water is produced by a 10-stage horizontal, 3900-rpm centrifugal pump, which is driven by a 800-hp diesel through a speed increaser.

This pump is also used to inject water into the Bonanza-Gilsonite pipeline to keep the slurry moving in case of power failure of the electrically driven plunger pumps.

Breaking costs consisting of labor, materials and maintenance of equipment, but less overhead, supervision, depreciation, etc. are now about $0.35 per ton.

One of the big advantages of the system is the tramming of the ore to the sump. AGC expects to sink a shaft only every 2½ miles on the vein for the installation of pumping stations. There is no electric or combustion engine power anywhere in the mine except at the pump station which has permissible electric motors and lights. These pump stations are sealed from the rest of the mine by draft doors and by a pressure and exhaust air system.

A portion of the success of this project must be attributed to the equipment manufacturers who have so ably assisted in developing special equipment for the company's use, such as the high pressure coupling used in connecting the three-in. schedule 80 pipe underground and the lightweight high pressure hose that makes the small tractor operational. There are other instances where manucturing ingenuity has assisted in the progress made to date.

It is the author's prediction that, in the not too distant future, water will be used to dislodge and tram metallic and nonmetallic minerals to an ever-increasing extent. Water, which is normally a burden in the mining operation, will be a valuable asset in breaking and transporting the ore.


# High Grade Results in Low Grade Ore

Two Marion 4161 machines are helping to point the way to high grade recovery of low grade ore in the Lake Superior region.

The diet of these machines is a hard, abrasive Jasper formation weighing 2.6 tons per yard. The Marions work on 40 foot benches in blasted pits ranging to 100 foot depths which may eventually reach 500 feet.

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# AMMONIUM NITRATE

**Here are the blasting stories of two widely separated open pit mines. Although each operation has its own method of mixing and loading ammonium nitrate and fuel oil, and different types of ground to blast, the net result is the same—greater economy**

# BLASTING COPPER ORE IN NEVADA

By

**FRANK QUILICI**

**Pit Superintendent**
**Nevada Mines Division**
**Kennecott Copper Corp.**

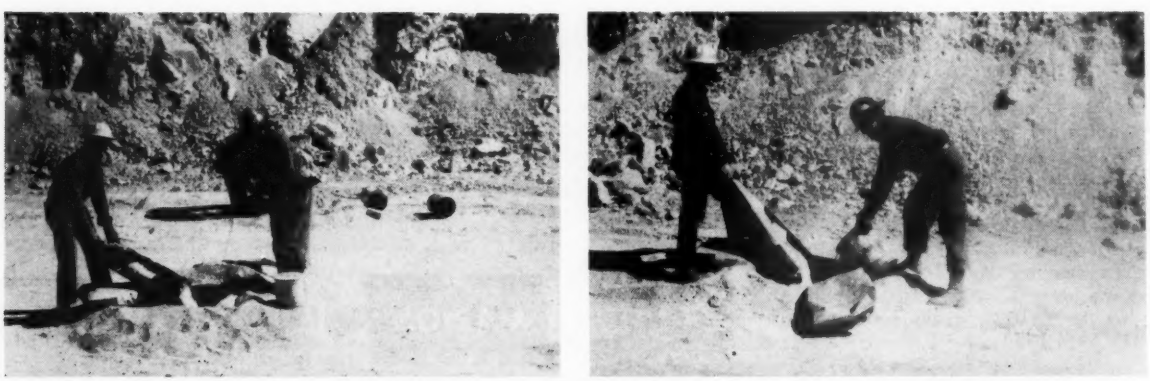
AT Nevada Mines Division, Kennecott Copper Corp., approximately 70,000 tons of ore and waste are mined per operating day. All blast hole drilling is accomplished with three Bucyrus Erie 40-R rotary drills, using nine-in. tricone bits; and one Ingersoll Rand Drillmaster, using a 7⅞-in. tricone or a 7⅞-in. percussion bit.

From a blasting standpoint there are five types of rock located within the pits: monzonite porphyry, volcanic rhyolite, silicified limestone, garnetized limestone, and jasperoid. The porphyries and rhyolites are easy to fragment. The limestones vary from easy to hard to fragment; the jasperoid is extremely hard to fragment and gives us the greatest percentage of blasting difficulties.

General drilling practice is to lay out a single row of blast holes on 20-ft centers spaced 25 ft from the toe of the pit bank. All blast holes are drilled six ft below the level to an average depth of 36 ft. The blast holes have an average burden of 32 tons per ft.

Until March 1955 all primary blasting was accomplished with 65 percent strength free flowing bag powder. The blast holes were chambered with

(*Continued on page 56*)



**Current practice at Nevada Mines Division entails loading holes by hand. Hole is primed with reinforced Primacord and one 5-in. by 25-lb, 65 percent Gelamite cartridge (left). Ammonium nitrate and diesel fuel are then poured in simultaneously (right)**

The company accords ammonium nitrate and all its associated compounds the same respect and treatment as are given to the more sensitive fixed-type high explosives

# BLASTING LIMESTONE IN MICHIGAN

By

**LEWIS J. PATTERSON**

**Manager—Northern District**
**Michigan Limestone Division**
**United States Steel Corp.**

THE Northern District of Michigan Limestone embodies two separate quarries, but in the interest of brevity, the discussions in this presentation will be restricted to the Calcite Quarry near Rogers City in the upper part of the lower peninsula of Michigan. While the quarry operations at the dolomitic limestone quarry near Cedarville, in the upper peninsula, are much more severe, the same general conclusions can be applied to both operations.

At the Calcite plant, high grade limestone is quarried from the Dundee formation. In this area the Dundee is made up of three strata, as it is in most areas of Michigan where it has not been subjected to glacier erosion in prehistoric times. The upper layer is identified as the Rogers City formation and in its undisturbed state is approximately 100 ft in depth. Underlying this, is a seven-ft ledge of magnesia-bearing limestone which, in turn, lies atop a lower bed of high-calcium limestone approximately 135 ft thick and identified simply as the "Dundee" ledge. Variations in chemistry make it necessary to quarry the magnesia stratum separately, and this has precluded the possibility of utilizing benching-type operations. These necessary quarrying operating techniques together with the fact that the whole formation is inclined at a slope of about 40 ft per mile make it necessary to quarry in varying bank heights from zero to 90 ft. Company experience sharply indicates that there are economies available in quarrying in greater bank heights, and all operating plans for the future make maximum use of such economies.

The Dundee formation, as a whole, lends itself readily to drilling and blasting, and fragmentation is usually not a serious problem. Secondary drilling and blasting is virtually negligible. Expressed in tons per lb of powder, the yield ratio is slightly in excess of five tons, or 0.2 pound of powder per ton of stone, expressed reciprocally. The cost of fragmentation is, however, a major item of total cost of production, and therefore receives the concentrated efforts of every supervisor who has any responsibility in this area.

## Thorough Mixing is Important

Dry-hole blasting techniques can be applied to approximately 60 percent of the company's operations, and it is in this area where the basic fundamentals have not materially changed, even after continual experimentation.

Early in the development of the use of the ammonium nitrate and fuel oil mixtures, several techniques were worked out which appear to be highly important to the overall efficiency of the blast. First, thorough

(*Continued on page 57*)

This mechanical loader insures thorough mixing of the nitrate and fuel oil and reduces manpower requirements to a minimum

(*Continued from page 54*)

several sticks of 1¼ by 8-in. dynamite.

Between March 1955 and October 1956, a series of tests was conducted using various akremite types of blasting agents. The first tests were conducted using commercial blasting agents. These blasting agents were ammonium nitrate prills coated with carbonaceous materials such as resin, lamp black, and finely divided coal. Later tests proved agricultural grade ammonium nitrate prills the most economical. Since October 1956 AGAN prills have been the primary blasting agent used in the Liberty and Veteran Pits.

### Six Percent Fuel Oil Mixture Used For Dry Holes

Ammonium nitrate was first used in the porphyry and rhyolite areas, which accounts for 50 percent of all primary blasting. Diesel fuel was adopted as the carbonaceous material and was introduced in the sacks in the proportion of 0.8 gal of diesel fuel to 80 lb of ammonium nitrate. Detonation was accomplished with two, 5-in. by 25-lb, 65 percent gelamite cartridges. Stemming material consisted of rotary drill cuttings.

Tests were conducted loading ammonium nitrate prills and diesel fuel in a six-in. pipe simultaneously. These tests proved that ammonium nitrate prills and diesel fuel can be thoroughly mixed in this manner. As a result of these tests, diesel fuel storage tanks were mounted under the bed of the truck which is used to transport the ammonium nitrate. At the present time the 80-lb bags of ammonium nitrate and 0.8 gal of diesel fuel, or approximately six percent by weight, are poured in the drill holes at the same time. The average charge is 10 lb of ammonium nitrate per ft of hole depth.

Further testing resulted in reducing the primer charge from two 5-in. by 25-lb, 65 percent gelamite cartridges to one 5-in. by 12½-lb cartridge. The primers are detonated with reinforced Primacord and safety fuse. The use of ammonium nitrate was then extended to all areas, with the exception of wet holes.

Experiments are currently being conducted using 1½ by 5-in., 65 percent gelamite stick powder threaded on Primacord as a detonator. The powder sticks are placed approximately one ft apart through the column of ammonium nitrate. This method of detonation is being tried in order to increase the propagation rate of the ammonium nitrate and improve fragmentation.

### Commercial Packaged AN Used For Wet Holes

All blast holes are generally blasted the same day they are loaded for safety reasons. It is interesting to note that due to extenuating circumstances one group of blast holes was allowed to remain loaded for 48 days and was successfully detonated nonetheless.

In certain portions of the Liberty and Veteran Pits, the drill holes are wet. The water level in wet holes will vary from one to 20 ft in depth. Until May 1958 all wet holes were blasted with 65 percent gelamite blasting powder.

During May and June, 1958, experiments were conducted using a commercial packaged ammonium nitrate blasting agent. During the first tests, blast holes were loaded with the 8-in. by 50-lb cartridges. Detonation was accomplished with 65 percent gelamite stock powder and 5-in. by 12½-lb., 65 percent gelamite cartridges. These holes were successfully loaded and blasted in areas containing a 20-ft column of water. During later tests, those blast holes with a maximum water level of three ft were loaded with the commercial packaged blasting agent up to the water level. The blast holes were then loaded to the required level with ammonium nitrate prills. Detonation was accomplished with 65 percent gelamite stick powder placed between the cartridges and spaced throughout the column of ammonium nitrate.

The results of the blasts using the 8-in. by 50-lb cartridges of commercial ammonium nitrate blasting powder, and the combination of commercial ammonium nitrate cartridges and loose agricultural grade ammonium nitrate compare favorably with those using the 65 percent gelamite powder. No appreciable difference could be noted in fragmentation of the rock. The use of these blasting agents reduced the cost of explosives for wet holes by $0.07 per lb.

Currently tests are being conducted using ammonium nitrate prills to blast the wet holes. The ammonium nitrate prills and diesel fuel are poured in water-resistant, tar-lined burlap sacks to produce an 8-in. by 40-lb cartridge. The cartridges are loaded in the blast holes in the conventional manner. No trouble has been encountered lowering these cartridges through a twenty foot column of water; however, time must be allowed for the cartridge to completely settle through the column of water. Detonation is accomplished by placing 1½ by 5-in., 65 percent gelamite stick powder, threaded on primacord, between the cartridges. All wet holes are blasted within two hours after they have been loaded. The blast results have compared favorably with 65 percent gelamite powder and the commercial ammonium nitrate. Further tests with this method will be made using various containers as wet holes are encountered in the pits. Successful application of this process will further reduce explosive costs for wet holes by an estimated $0.02 per lb.

### Bulk Purchases Offer Possible Advantages

Ammonium nitrate prills are delivered to Nevada Mines Division in 40-ton railroad car lots. The railroad car is spotted on a siding and is used as a temporary magazine. One 40-ton car is delivered each week, which makes it more economical to pay demurrage than to handle ammonium nitrate twice. Dynamite for primers and secondary blasting is delivered by truck and is stored in a conventional powder magazine.

The possibilities of purchasing bulk ammonium nitrate prills is being investigated. If this plan is adopted, the ammonium nitrate will be stored in a special hopper and delivered to the blast areas in a special powder truck. The powder truck will automatically mix the ammonium nitrate and diesel fuel and load it directly into the drill hole. Savings in ammonium nitrate costs and manpower requirements are anticipated upon installation of this method.

Table I depicts the comparative blasting efficiencies and costs between the free flowing bag powder, akremite

Table I

PRIMARY BLASTING DATA

| | 65% Bag Powder | Akremite Type | Ammonium Nitrate |
|---|---|---|---|
| Blasting Efficiency | | | |
| Tons Blasted per Lb Explosive | 6.73 | 5.64 | 4.81 |
| Lb Explosive per Ton Blasted | 0.15 | 0.18 | 0.21 |
| Blasting Cost per Ton | | | |
| Primary Explosive | $0.024 | $0.013 | $0.008 |
| Diesel Fuel | | | 0.001 |
| Primer | 0.001 | 0.003 | 0.002 |
| Primacord-caps-fuse | 0.002 | 0.002 | 0.002 |
| Labor | 0.008 | 0.008 | 0.003 |
| TOTAL | $0.035 | $0.026 | $0.016 |

type blasting agents, and ammonium nitrate prills.

The lower efficiencies of the akremite type blasting agents and ammonium nitrate prills are due to the following reasons:

1. During the time free flowing bag powder was used as a blasting agent, all blast holes were chambered which improved back break. This practice was discontinued, for safety reasons, during the time akremite type blasting agents were adopted.
2. During the time free flowing bag powder was used as a blasting agent, a portion of the Liberty Pit was mined in "free digging" material. Past records do not separate free digging material from the blasted material.

The lower labor costs incurred with the use of ammonium nitrate prills are due to the following reasons:

A. When the practice of chambering holes was discontinued the manpower requirements were reduced.

B. During the time free flowing bag powder was used as a blasting agent, blast hole drilling was accomplished with churn drills and stemming material was hauled to the blast area by the powder crews. Upon adoption of rotary drills, suitable stemming material was readily available and the manpower requirements were reduced.

C. Reorganization of the Drilling and Blasting Department and work load studies have further reduced manpower requirements.

**BLASTING LIMESTONE**

*(Continued from page 55)*

mixing of the nitrate and fuel oil is essential to good efficiency. Incomplete mixing does not permit complete high-order detonation, and is evidenced by the emission of yellow nitrous oxide gases after firing. Resulting decreases in the yield are quite evident. In order to assure complete mixing and at the same time to keep manpower requirements to a minimum, a mechanical mixer was conceived and incorporated in a mechanical hole loader.

A 3½-ton stake-body truck was selected as the basic machine for transporting, mixing and loading. A small air compressor was mounted on the front, and a 150-gal fuel oil tank was mounted on the side of the truck. At the rear of the truck platform a hopper, built of aluminum for its nonsparking characteristics, was mounted in a manner so an adjustable loading spout would clear the end of the truck. The lower end of this hopper is approximately 12 in. square and houses a gate mechanism to control the flow of ammonium nitrate. As the nitrate is poured into the hopper and strikes the gate, electrically operated relays activate a solenoid valve which permits the fuel oil to be injected as a finely divided spray through six nozzles spaced around the hopper tube. As the nitrate, in amounts predetermined for each hole, clears the gate, the fuel oil is stopped when the gate closes. The proper percentage mix of fuel oil and nitrate is assured by the use of a flow control meter for the fuel oil and the uniform flow of the nitrate through an adjustable hopper opening. With the fuel oil injected under pressure as a spray into the free-falling nitrate, thorough mixing is assured. The machine as described is merely a prototype model. It has already been subjected to a number of changes and improvements.

The design objectives of this machine were fully realized when thorough mixing of the nitrate and fuel oil was attained, and when the company was able to reduce the manpower requirements. Previous to the use of nitrates and fuel oil mixtures, a crew of 11 men was required to handle and load the fixed-type explosives. At the present time, in addition to the foreman and a truck driver, two men are required on the truck platform to place the sacks on the hopper, to open the sacks and pour the nitrate into the hopper. Two additional men are required on the ground to place the primers, handle the primacord, and back-fill the holes with stemming material. Thus, the crew is reduced to a total of five, in addition to the foreman, when this technique is used.

Many quarry operators do not feel that the efforts in making certain of thorough mixing are at all necessary. In this light, perhaps Michigan Limestone's treatment is too complex. However, it is the company's firm belief that mixing is important, and the results adequately support this belief. Additionally, the loader can be justified on the basis of a reduction in manpower requirements. Furthermore, on a pound-for-pound substitution basis of nitrates for fixed-type explosive, the overall fragmention results are better.

### Proper Priming is Vital

A second concept of utmost importance is that of proper priming. For the past several months much experimental work has been done in this field. The initial results clearly indicate the value of several techniques to which the company adheres. In the column, explosive primers should not be spaced in excess of 20 ft and the more nearly the primer can be extended throughout the column, the better the results seem to be. Spacing small primers of high energy, at short intervals on the Primacord, in the center of the column, was most effective. The problem in this area, of course, is to gain the benefits of a high-energy explosive for priming without sacrificing any aspects of safety. Reference is made to the gelatin-type primers in the category of 80 percent. For reasons of safety, the use of 80 percent gelatin-type primers has been discontinued in favor of primers with less energy and correspondingly less sensitivity. Company experiments with 400-grain Primacord alone without conventional primers have shown only moderate results even when usage and spacing is in excess of that recommended by the manufacturers. The theory of a continuous primer column is more nearly approached with this technique, but so far the use of continuous lengths of 400-grain cord is not economically justified. Further tests in this field are scheduled for the near future.

Tests conducted with a continuous 180-grain cord as a primer were moderately successful when using uncoated prilled nitrate and fuel oil. Detonations were approximately of a medium order even with the 180-grain cords. Further tests using uncoated prills and one-ft lengths of 400-grain cord spaced at two and three-ft intervals on 50-grain cord are currently being studied, and the results will be forthcoming in the near future. Preliminary conclusions drawn from experimental results obtained to date indicate further success is probable.

### Very Little Success in Blasting Wet Holes

Uncoated prills present a problem of storage from the standpoint of absorption of moisture. One manufacturer has indicated a willingness to consider packaging in a moisture-resistant bag. In addition to the possibility of the use of primacord as a primer, further benefits would result from the elimination of the inert coating material which accounts for two to six percent of the total weight. In other words, the weight of the inert coating would be replaced by nitrate with the resulting increase in explosive energy at no additional cost.

The introduction of commercially compounded agents packaged in waterproof or water-resistant containers has materially improved the techniques of wet-hole blasting. A number of manufacturers have introduced such a product with marked improvement in costs over that of the fixed-type explosive. However, with the margin of difference between the cost of these commercially compounded agents and the in-the-hole cost of the ammonium nitrate and fuel oil mixtures, the company is still diligently searching for a product which will defy water and provide a cost more comparable with that experienced in dry-hole blasting.

Candidly, Michigan Limestone has been eminently unsuccessful in obtaining any satisfactory results with super-saturated solutions. A number of additives have been used with little success. The technique of pumping the holes dry and then introducing a water-resistant compound shows some promise in areas where water does not rapidly re-enter the hole after pumping. Reports of successes with the direct introduction of field-compounded agents and commercially compounded agents into wet holes have been prevalent for some length of time. The author's company would be extremely interested in any supplier or user who could and would provide us with any information along this line.

### Drilling Practices Improved

While the benefits associated with the use of the low-cost blasting agents have been substantial, such benefits have not been restricted to this field alone. Of primary importance and significance are the substantial benefits obtained from a change in drilling techniques.

Prior to the introduction of ammonium nitrate into the blasting practices at the Calcite plant, an 18 ft by 18-ft burden-spacing pattern was used in conjunction with 6¼-in. diameter drill holes. The fragmentation results obtained at that time were satisfactory and attempts to increase the burden and spacing beyond 18 ft were unsuccessful. On the contrary in some areas where unusually hard stone was encountered, the patterns had been reduced to 16 ft, initially, under the impression that the theory of a critical mass was involved in the ammonia based agents, the hole diameters and the burden-spacing patterns were increased. This started a trend during which successive increases showed no deterioration in results, until the company now employs a 12¼-in. hole and a burden-spacing pattern of 27 by 30 ft. The simple arithmetic involved here sharply indicates the substantial advantages gained therefrom. The possibility of further increases in diameters, burdens and spacings, with corresponding increases in benefits, is not being discounted. If good results could be obtained from a cistern-sized hole in an acre of stone, there would be no hesitation to employ such extremes.

Recently the company has become aware of legislative action in some areas seeking to establish statutory standards for the handling, loading and firing of the so-called low-cost blasting agents. If legislation of this kind is enacted and the standards imposed thereby are not excessive, and do not extend beyond those now in force for fixed-type high explosives, or preclude on-the-site-mixing, present practices will not be materially affected. This is because Michigan Limestone accords ammonium nitrate, and all of its associated compounds, the same respect and treatment as are given to the more sensitive fixed-type high explosives. Rules for storage and handling the nitrate are strictly enforced and added precautions are taken to dispose of any spillage and accumulation of dust and fuel oil in the proper recommended manner. All equipment including the electrically operated relays, motors and lights meets code requirements and such equipment is independently guarded.

The benefits derived from the use of nitrate and its associated compounds in blasting limestone have been substantial. One of the reasons that these benefits have been significant has been the free exchange of technical information among the people in the quarrying and mining business. Michigan Limestone has welcomed this opportunity to discuss drilling and blasting practices with you and are hopeful that through the continued exchange of technical information continuing progress may be made in the techniques of using ammonium nitrate and its compounds as blasting agents.

# Engineering of A-C Underground Power Systems

**How do you determine conductor size, conductor spacing, distribution and utilization voltages, and the materials needed for an a-c power installation? These are some of the questions considered by the Committee on Underground Power, AMC Coal Division, in a report slanted toward the engineer who is considering the use of a-c underground**

By

**C. S. CONRAD**
**Subcommittee Chairman**

CONTINUOUS mining units with a transportation system properly geared to the mining rate is the ultimate goal for mechanized coal mining. There can be no doubt that mining equipment manufacturers are making great strides toward building the type of machines which will do the job. However, there is also no doubt that such equipment is and will be larger, faster and require considerably more electric power.

The high production equipment must be designed with certain dimensional specifications to conform with mining conditions, maneuverability, etc. It follows that the machine will be compacted to a degree requiring closer machining tolerances, special materials and motor sizes which are adequate within the prescribed nameplate ratings.

Accepting these facts, in a majority of the older mine plants the power systems are inadequate to the needs of high production mining equipment.

There have been successful installations of large d-c equipment wherein the face power system was kept isolated from the haulage system. This can be done but, aside from economic considerations, many other problems are introduced.

The problem of providing proper utilization voltage for these higher power demands can be resolved in better voltage regulation. Both a-c and d-c motors and distribution systems have their limitations, which are further magnified by laws limiting utilization-voltage maximums; but the trend towards increased mechanization and the increased demand for electric power at points remote from the power sources may gradually force a turning to a-c powered equipment. Also, a revision of mining laws to permit utilization voltages that are best suited to the needs of the industry, as well as to the safety of the equipment-operating personnel, seems to be a necessary requisite for future progress.

In the comparison of a-c and d-c systems, voltage regulation is an important factor. Both a-c motors and controls require much better regulation than their d-c counterparts. The added elements of power factor, line reactance, high motor-starting currents and high contactor drop-out voltages tend to offset the greater voltage compensating characteristics of the a-c system. The regulation of a d-c system is subject only to line resistance and relatively low motor-starting currents, and is not subject to the above-mentioned factors inherent in a-c systems.

The greatest problem in a-c regulation occurs during the motor start-up, and, as a result, the a-c conductor choice is determined chiefly by the motor-starting current and torque demand, plus the added factor of a-c contactor drop-out ratings.

For approximately equal torques of 200 percent full-load ratings, the starting current for a-c motors is approximately 2½ times that for d-c motors. The a-c motor requires a regulation half that for a d-c motor to meet these conditions.

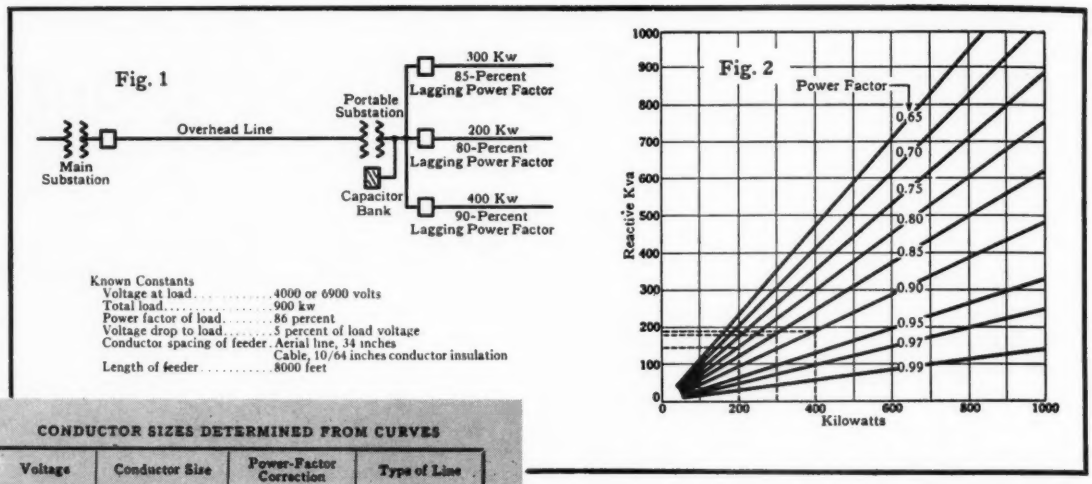
An a-c power system can afford a high degree of flexibility and offers maximum protection under fault or overload conditions. Basically, in an a-c system, a grounding method can be adopted which is many times safer than any devised for a d-c system. The method, properly applied, will achieve a most desirable reduction in hazards to machine operating personnel; viz., shock, mine fire and explosion.

There remains the problem of voltage regulation and in an a-c system the calculations are more complicated than those encountered in solutions for a d-c system. Such calculations are analyzed and adequately simplified in the text of a section of the paper, "Power for Underground Mines."*

## SOLUTION OF A-C DISTRIBUTION SYSTEMS

A-c systems involve several considerations not present in d-c sys-

** Part of the information contained herein is based on the AIEE paper, "Power for Underground Mines," transactions Volume No. 72, 1953, Part 2, applications in industry, pages 217 to 225, by J. Z. Linsenmeyer and A. G. Owen, Westinghouse Electric Corp.*




**CONDUCTOR SIZES DETERMINED FROM CURVES**

| Voltage | Conductor Size | Power-Factor Correction | Type of Line |
|---|---|---|---|
| 4000 | 300 000 cm | None | Aerial |
| 4000 | 4/0 | 95% Lagging | Aerial |
| 4000 | 1 | 97% Leading | Aerial |
| 4000 | 3/0 | None | 3-Conductor Cable |
| 6900 | 2 | None | Aerial |
| 6900 | 2 | None | 3-Conductor Cable |

**Fig. 1. A small section of an a-c distribution system. Problem: to determine the conductor size required to maintain a five percent voltage regulation, and the best transmission voltage. See text for solution. Fig. 2. Relationship of kvars to kw at various power factors**

tems, which tend to complicate the calculations of an a-c line. However, two easy and fairly accurate methods are available to solve a-c distribution systems at either primary or utilization voltages.

For example, taking a small section of an a-c distribution system, as shown in figure 1, the problem is to determine the conductor size required to maintain a five-percent voltage regulation, and the best transmission voltage.

The first step is to determine the total load and combined power factor appearing at the low-voltage substation. Adding the kilowatt loads directly, the total is found to be 900. Using figure 2 to determine the kvars of each load, the total is 525 kvar for the 900-kw load, and from figure 2 again, it is seen that this represents a power factor of 86 percent lagging. Now a conductor size can be chosen.

Conductor sizes as a function of power factor and "kwd" for one-percent voltage regulation are shown in figure 3. The term kwd is the product of kilowatt load and feeder length in thousands of feet for a nominal mean conductor spacing of 34 in. The 900-kw load for a distance of 9000 ft at five-percent regulation, then, represents 1620 kwd. At a transmission voltage of 2300 volts, at 86 percent power factor, there is no conductor curve, which means this voltage is unsatisfactory. Checking a voltage of 4000 volts, a 400,000 circular-mil conductor is found to be satisfactory. If this is too large, either a higher voltage or power-factor correction can be tried.

Trying a voltage of 6900 volts first, a No. 2 conductor appears satisfactory. If power-factor correction is used, a 4/0 conductor at 2300 volts would require a leading power factor of 97 percent, while at 4000 volts it would require a lagging power factor of 95 percent.

Referring to figure 2 again, observe that a power factor of 95 percent lagging shows 300 kvar for 900 kw, leaving 225 kvar to be compensated for by capacitors. By a similar method note that 750 kva of capacitors would be required for a 97-percent leading power factor. The cost of a capacitor installation can then be balanced against the cost of conductors and the higher transmission voltages.

Now check the same problem, using a three-conductor cable. Referring to figure 4, which is a duplicate of figure 3 but is for cable spacings, it is again found that 2300 volts is not a suitable transmission voltage, that 4000 volts requires a 3/0 conductor, and that 6900 volts requires a No. 2 conductor.

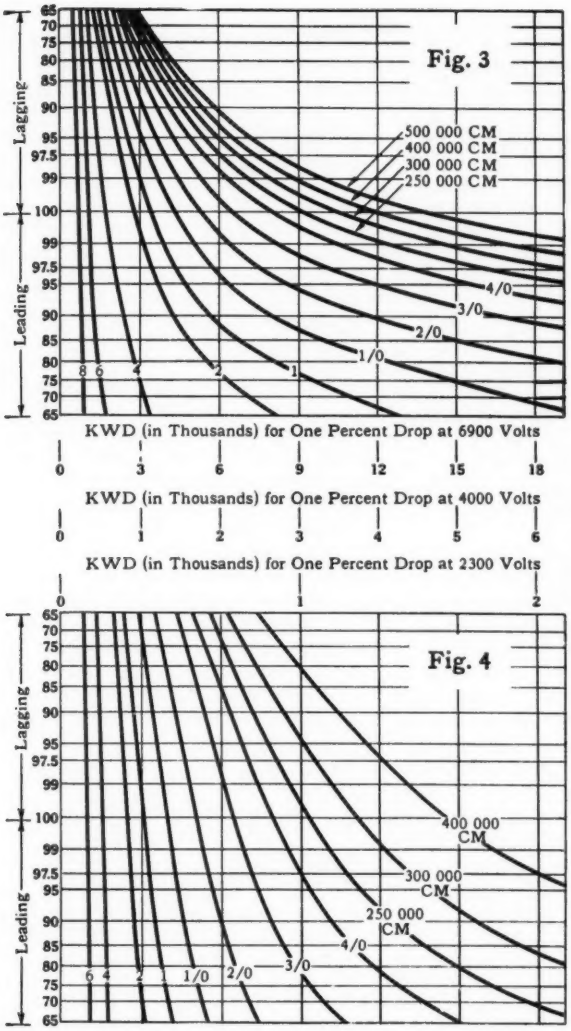
If the power factor is to be improved, the same procedure would be followed as before, but a closer look at the slopes of figure 4 curves shows that little reduction in conductor size can be achieved. As an example, to reduce the conductor size from 3/0 to 2/0 the power factor must be improved from 85 percent lagging to 98 percent lagging, and to reduce to the next conductor size of 1/0 requires an improvement to 85-percent leading power factor. Here again the importance of a small line reactance is apparent, as is the small gain derived from shunt capacitors, where cables are used.

These curves can be used for voltages of 230 or 460 by taking the square of the voltage ratios as a multiplier. For example, 2300 volts is ten times 230 volts, and the square of this ratio is 100. Ten kwd at 230 volts is thus read as 1000 kwd on the 2300-volt scale.

The last check is the thermal capacity of the conductor sizes chosen. Referring to figure 5, at 4000 volts and 85-percent lagging power factor, a No. 4 conductor is adequate for the pole line, and a No. 1 conductor is adequate for the cable. Because these sizes are smaller than those chosen from 3 and 4, it is obvious that the condition of thermal capacity is fully satisfied.

There are occasions where conductor spacings other than those discussed so far are required. For this reason an alternate method is sometimes used for a-c line calculation; this method is also advantageous in that it can easily be jotted down in a pocket memo or diary, and the calculations involved are simple.

The complete method is shown in figure 6, which is more accurate than many short-cut methods. These formulas can be worked in either direction, in that a conductor size can be assumed, as well as all but one of the other variables, and the last variable determined; or a load and all but one of the other variables can be assumed




Figs. 3 and 4. Conductor and cable sizes as a function of power factor and "kwd" for one-percent voltage regulation

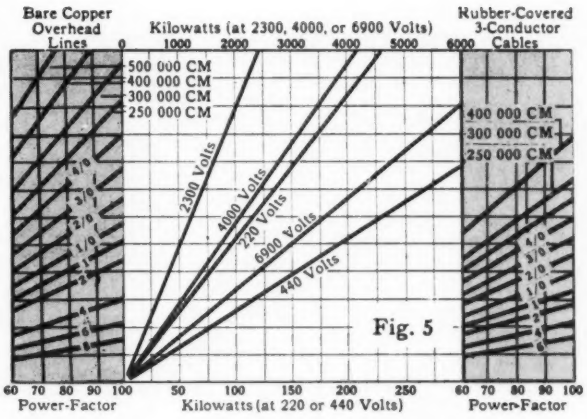



Fig. 5. The adequacy of the conductor and cable sizes can be determined from this group of curves. This indicates whether the chosen conductors have sufficient thermal capacity for the required job

and the remaining variable determined.

The term kwd, as before, represents the load in kw per one-percent regulation per 1000 ft of line one way. Should it be desired to use R and X as the resistance and reactance, respectively, per mile of line instead of per 1000 ft, then the kwd will be per mile of line instead.

If trigonometric tables are not available to determine the term "tan $\theta$" from the power factor, it can easily be calculated from the power factor as shown.

Lagging and leading power factors are taken into consideration by the sign between the R and X terms, being plus for a lagging power factor and minus for a leading power factor. Either three-phase or single-phase lines can be calculated. The resultant kilowatts obtained from the formula are for a three-phase line; and dividing this result by two will give the kw for a single-phase line of the same size, length, etc.

Having determined wire sizes, conductor spacings, distribution and utilization voltages, which best satisfy the plant requirements, the next step involves specifying materials which will be needed. Also considered at this time is the plan for an installation.

## THE HIGH VOLTAGE SYSTEM

### Surface Substation Considerations

1. The power source should provide for "resistive" current limiting on ground fault of the power conductors which connect to the underground transformer and distribution substation.
2. Ohmic impedance of the ground resistor should be of such value that, under maximum ground fault current, the voltage drop in the ground circuit external to the neutral resistor would not exceed 100 volts. Preferably limit this voltage drop to a lesser value. The resistor should be rated for maximum ground fault current continuously and insulated from ground to a value equal to the line voltage.
3. Grounding:
   a. Substation ground should be a counter-poise system having equipment frames, fencing and lightning arrester grounds interconnected. Maximum recommended value, two ohms to ground.
   b. Safety ground designated to be the ground connecting to the current limiting resistor and separated by 50 ft from the substation ground. Recommended maximum value, five ohms to ground.
4. There should be a circuit breaker connecting the underground cable or cables to the power source. The circuit breaker equipment, of proper voltage, current and interrupting rating should include:
   a. Current transformers in all phases.
   b. Overload relays having inverse time and instantaneous elements.
   c. Ground relay to be a low energy type. The current transformer for this device being a suitable unit and connected between the "above ground terminal" of the ground resistor and the transformer neutral.
   d. Circuit breaker tripping energy should be unaffected by voltage dip under fault conditions.
   e. There should be a device provided which would continuously check the ground wire continuity from the power source to the underground transformer; the device would cause the breaker to trip if the ground circuit resistance increases beyond the value recommended under item 2 above.
   f. A "key interlock" should be provided at the power source circuit breaker. Other components of the same power circuit, which are

arranged so that they may be disconnected, should have key interlocking using the same lock series as used on the source breaker.

5. There should be a "visible opening" type switch or switches provided so that personnel can safely service the equipment.
6. Lightning arresters should be installed at the point of cable entrance underground. If located remote from the substation a separate driven ground should be installed.
7. In general, the surface substation should be constructed and maintained to conform with good and practical standards.

### Borehole Cable Suspensions

A number of satisfactory methods are already shown in cable catalogs. The method to be employed will depend upon cable size, number of conductors, type of cable and weight of cable to be suspended. It is recommended that the cable manufacturer provide installation details and those specifications be followed.

### Cable

Type:

1. For permanent installation of multi-conductor cable, "Mine Feeder Cable" is of adequate construction. The cable would differ only in that two ground wires would have combined cross-sectional area not less than half the cross-sectional area of one power conductor while a third "insulated ground wire" would be of sufficient size to provide a circuit for ground testing on a continuous basis. No. 10 B&S stranded copper conductor, insulated for 600 volts, might be considered.
2. For permanent installation of grouped single conductor cables the single conductor Mine Feeder Type could again be considered. The catenary suspension for the cable could serve as the ground conductor but must have 50 percent of the carrying capacity of one power conductor, unless installed in parallel with other ground conductors.
3. Portable cable should be type SHD with conductors having a minimum of 133 strands.

Voltage Rating:

1. Ratings to 15 kv and more are available as far as cables are concerned.
2. In consideration of available cable couplers of multi-conductor shielded type, eight kv is presently the maximum voltage to be considered.
3. Higher voltage ratings may be considered for installations where grouped single-conductor cables and permanent type junctions and terminations can be justified.

Terminations:

1. Shielded couplers for multi-conductor cables are available to 7.5 kv voltage rating. Couplers should be provided with mechanical interlocking to the nearest power source switch equipment.
2. Shielded couplers for single-conductor cables are available for use on a 7.2 kv system. The coupler should be provided with mechanical interlocking as above.
3. Interruptor type high voltage switches, in cubicle or cell structure, could be used for termination and interlocking could then be omitted.
4. **Caution:** On all cables rated at 5.0 kv and above, particular care must be taken in the proper installation of stress cones.

Cable Installation:

1. At mine level the cable could be supported from a catenary which is carried on insulators attached to the roof. The insulators should have a 600-volt rating. Strain devices to be attached over the jacket and with distributed stresses such that the cable jacket is not damaged. Where couplers are used there should be no strain loading on the coupler.
2. Installation of Mine Power Feeder Cable, self-supported on properly spaced insulators is acceptable and/or laid on the mine floor in other than tracked or haulage entries, except where prohibited by State regulations.
3. The last inby length of cable could be Type SHD and may be laid directly on the mine floor, extra length to be stowed in a large "figure eight" as space permits. Vertical stowage on wood safety posts would be preferred.
4. All high voltage cables to be installed in entries which are on intake air.

### Branch Circuits in Underground System

1. Each circuit should connect through an interruptor switch. Preferably, circuit breakers would be used and, with selective relays, fault conditions and effects could be localized.
2. Ground wire monitoring is preferred although duplication of devices becomes necessary when a branch circuit is added to the system. Check circuits can be projected to include branches by adding insulated check wires outside the cable.

## THE LOW VOLTAGE SYSTEM

### Underground Substation Considerations

Transformer:

1. This unit physically separates the high voltage and low voltage systems; however, the wired ground circuits of both systems are connected solidly.

$$KWD = \frac{E^2 \times 10^{-5}}{R + X \tan \Theta}$$

KWD—Load in kilowatts per one percent regulation per 1000 feet of line
E—Voltage at the load
R—Resistance per 1000 feet of one conductor
X—Reactance per 1000 feet of one conductor for spacing used

$$\tan \Theta = \frac{\sqrt{1 - PF^2}}{PF}$$

tan Θ—Trigometric tangent of angle, the cosine of which is the power factor of the load
PF—Power factor of the load

$$KW = \frac{KWD \times \text{Percent VR}}{D}$$

KW—Power in kilowatts to be transmitted
Percent VR—Percent voltage regulation desired
D—Length of feeder in thousands of feet

1. In the top formula use $(R + X \tan \Theta)$ for lagging power factors, and $(R - X \tan \Theta)$ for leading power factors.
2. For three-phase power multiply kilowatts by 1; for single-phase power divide kilowatts by 2.

**Fig. 6. A calculation method for a-c distribution lines. These formulas enable simple solution of system factors**

2. Windings can be open, semi-closed or of the sealed type, but should present no fire or explosion hazard.
3. The problem of good performance and economical maintenance will depend on local conditions and, when these factors are weighed against initial cost figures, a decision as to type can be made.
4. A neutral connection must be provided in the low voltage side of the transformer (secondary), or a neutral must be established in the form of a grounding transformer connected to the secondary leads.

Circuit Breakers:

1. On a power center having low voltage feeders extending to low voltage load distribution centers, separate circuit breakers are necessary to protect the feeders.
2. On a power center having distribution centers built integral, the individual distribution breakers would suffice since the main bus is not exposed. However, a bus circuit breaker would afford back-up protection on fault in any one load circuit. Tripping could occur on both the feeder and bus breakers. There should be trip coordination on overload and ground current relaying so that only the faulted feeder circuit loses power. However, there should be no delay introduced on short circuit operations.
3. Ground relay should be sensitive to fault current of at least one-third the value of maximum ground fault current for the system used.

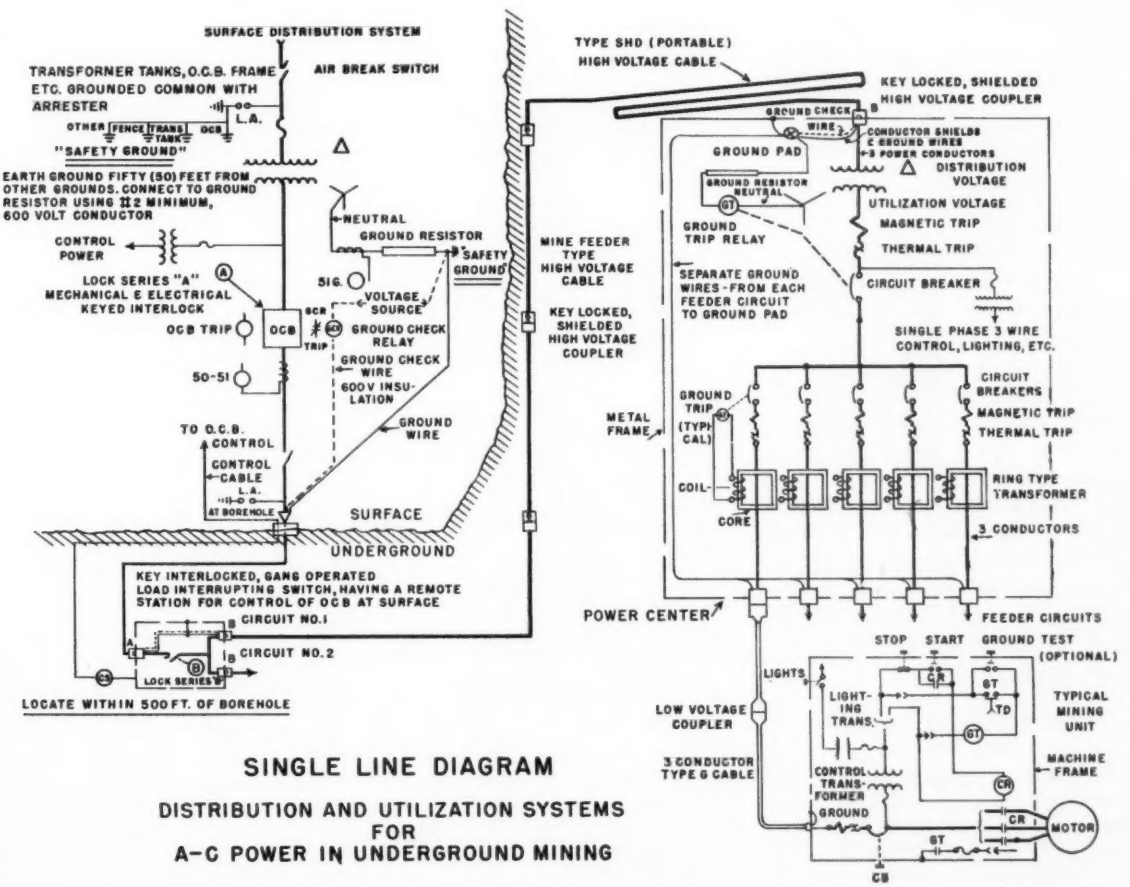
Neutral Resistor:

1. The thermal rating of the resistor must be continuous for the current value derived from the ohmic rating and the voltage rating of the unit.
2. The ground fault current value in the majority of units presently manufactured (480 volt systems) ranges from 10 to 17 amp. Ground detection and trip devices recommended for use with these particular units have performed satisfactorily. Regardless of prevalent argument, the desired result is positive ground trip relay operation with a minimum exposure voltage hazard while the fault is being detected and cleared.
3. Grounding resistors here considered afford limits wherein relays sensitive to one-third the maximum ground fault current are available.
4. One end of the neutral resistor should be connected to the safety ground and the other terminal should be carried insulated to the transformer neutral.
5. Low voltage and high voltage ground circuits to be metallically connected but have no metallic connection with any d-c system.

Cable Connectors:

1. Adequate current carrying capacity and suitable voltage rating are required.
2. They should be designed for speedy make or break connection.
3. They need not be permissible if always located in entries carrying fresh air.
4. Covers should be provided to protect exposed connector ends.
5. Safety circuit type connectors are

(*Continued on page 66*)




**SINGLE LINE DIAGRAM**

**DISTRIBUTION AND UTILIZATION SYSTEMS FOR A-C POWER IN UNDERGROUND MINING**

# Improvements in FILTRATION

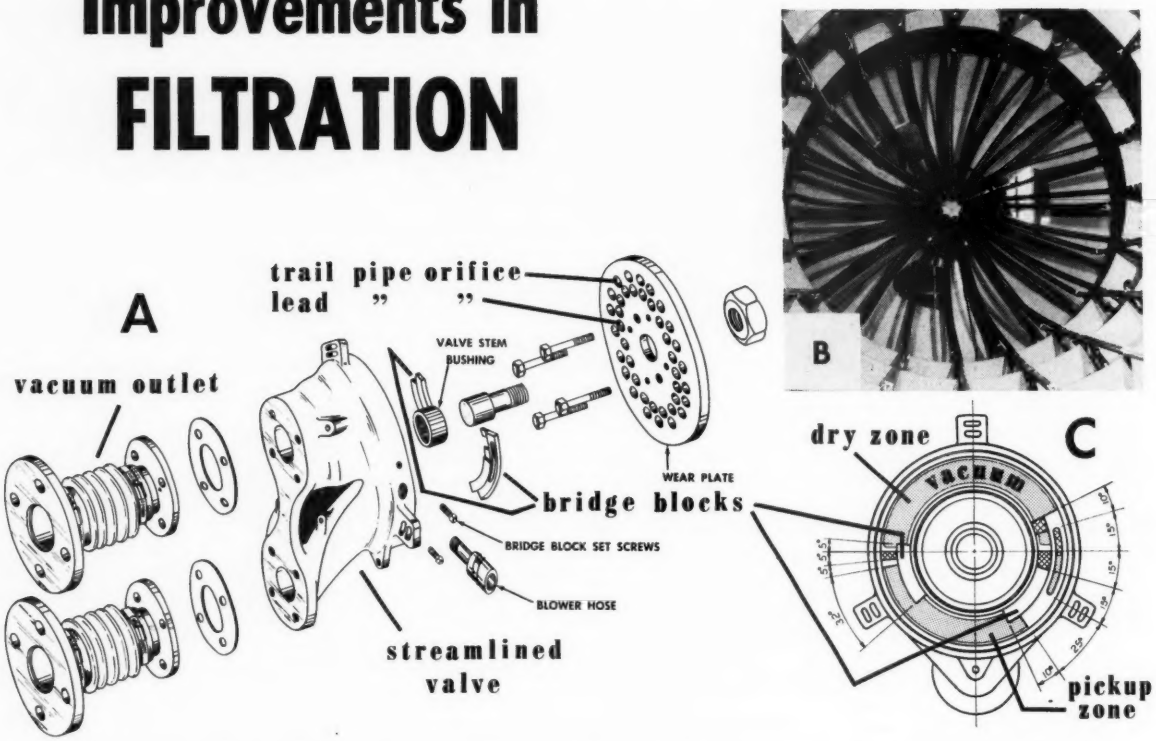



Fig. 1. (A) Assembly sketch showing concentric arrangement of trail pipe and lead pipe orifices in wear plate; concentric bridging for separate control of lead and trail piping, and streamlined valve. (B) Interior of eight-foot diameter filter drum shows separation of lead and trail pipes and use of hose sections in internal piping. (C) View of valve face bridged for air purge operation

**THE improvements in filtration are legion and, as in many other fields, these improvements are frequently nothing more than adaptations of ideas from one industry to another. However, by such means do all parties ultimately profit and by such means does industry grow**

By

**ROBERT B. THOMPSON**

**Filter Division**

**The Eimco Corp.**

### Correct Filter Sizing Offers Real Savings

Liquid-solid separations have become more and more important in process metallurgy. As processes become more complex and capital costs higher, the need for more economy in operation and precise sizing of equipment increases. No longer can the builder of a plant afford the luxury of over-sizing equipment merely to be on the "safe side".

The governing factors in filter sizing are:

1. Cake formation rate
2. Dewatering rate to obtain desired final moisture content
3. Rate of removal of soluble values or contaminants
4. Rate of thermal drying of the filter cake

In each filtration problem one of these factors will be controlling. If filter sizing is based on this factor then real savings can be made in costs, both capital and operating, and in operating results.

The above concept of filter sizing is one of the notable improvements in the application of filters.

The progress made in the production and application of flocculating reagents is notable. The many synthetic and natural flocculants which have been developed have demanded new dispersion devices.

Turbine type agitators can result in flash mixing of reagents with consequent major savings in consumption, and magnified effectiveness, of the reagents.

The flocculating reagents themselves have been subjected to constant improvement and refinement. The result is that comprehensive investigative work is indicated before selecting a given flocculant. Actually, these valuable organics can be almost tailor-made to fit the given problem. Such custom tailoring is yet expensive; but economical applications have been made and are increasing.

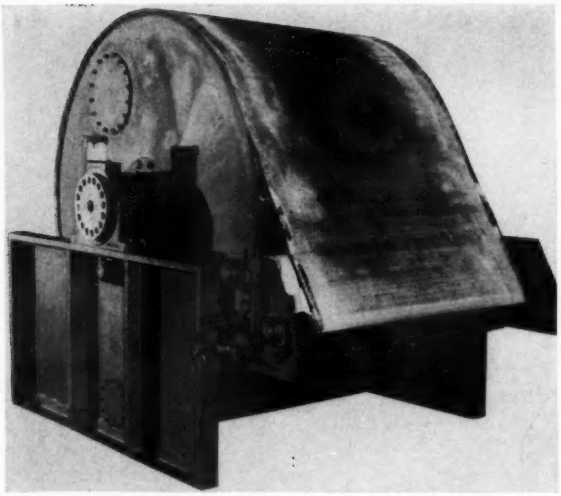


Fig. 2. Removable belt drum filter with woven stainless steel belt. Unit is now available with cloth belt.

## Improved Mechanical Design Means Greater Efficiency

The mechanical design of filters reflects the continued effort of manufacturers, and the stimulating demands of the users for more efficiency. The constant effort to reduce internal friction, thereby increasing efficiency and economy, have led to the use of larger and larger internal piping. The use of sweep bends instead of elbows increased hydraulic capacity. The separation of lead and trail piping in drum filters (figure 1 A and B) not only decreases friction loss, but materially improves liquor separation.

The reader will note that by separating the lead and trail pipes their functions can be separately controlled. Thus, in a cake washing situation original liquor can be drawn through the trail pipe and wash liquors can effectively be drawn through the lead pipes. This increased precision in liquor separation yields higher-grade strong liquors, lower-grade wash liquors and greater wash efficiencies with less wash water consumption.

The development of a streamlined valve has further reduced friction losses (figure 1A). Obviously, with the limited driving force available (vis., atmospheric pressure) any pressure drop, except across the filter cake, is wasteful. This explains the determined efforts in this direction.

One of the most notable adaptations is the air purge system. This is not a new device, but its application to the metallurgical field is recent.

Lead and trail pipes enter the valve in separate concentric pipe circles (figure 1A). The valve bridging for lead and trail pipes is separate and distinct (figure 1C). The vacuum is applied to both lead and trail pipes in the pick-up zone. As the lead pipe emerges from the slurry it is bridged off, and all vacuum is applied through the trail pipe. This allows the filtrate to seek the lower pipe and concentrates the flow. At or near the horizontal the trail pipe is bridged off. This effectively separates the pickup and dry sections and allows vacuum regulation if desired, and also provides for filtrate separation. In the dry or wash zone, vacuum is again applied to both lead and trail pipes thus providing maximum hydraulic handling capacity. At the end of the drying cycle the trail pipe is bridged off. The filtrate, aided by gravity, seeks and is removed through the lead pipe. Then the trail pipe is opened to atmosphere—the air sweeps through the valve, then the trail pipe, down the deck and out the lead pipe. This passage of air effectively sweeps away any filtrate remaining in the piping or in the decking. At the discharge point the lead pipe is blanked and low pressure air is introduced through the trail pipe for cake dis-

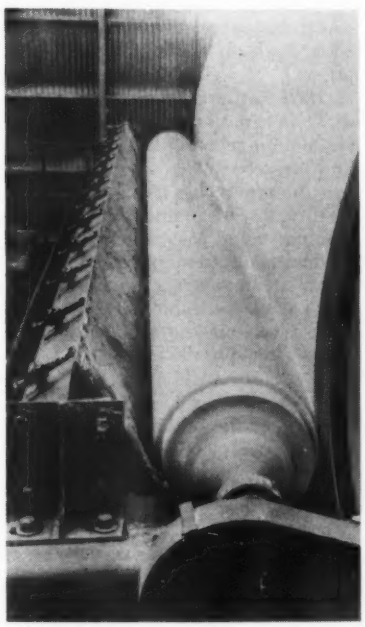


Fig. 3. The development of adjustable scrapers has improved the operation of the roll discharge

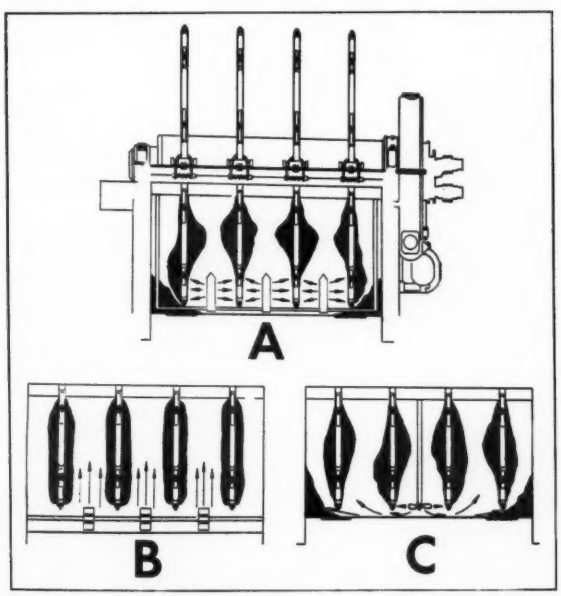



Fig. 4. Sketch showing undesirable effects of oscillating agitator (A), and impeller agitator (C), contrasted with rotary paddle agitator (B) which provides properly directed agitation

charge. With no residual filtrate in the piping or on the deck there can be no blow-back. With the complete elimination of blow-back, final cake moistures are lowered, soluble recovery or contaminate removal is improved and all around better results are obtained. At Algom Uranium the air purge device resulted in approximately five percent improvement in soluble recovery.

### Removable Belt Drum Filter Developed

For many years industry has searched for a way to provide constant removal and re-application of a filter cloth on a drum filter. Patents on such devices were issued as early as 1868 to Helem Merrill. In all cases early failure resulted because of (1) cloth alignment troubles, and (2) end and cross seal troubles. Sometime ago a removable belt drum filter (figure 2) overcame both of these troubles using a steel mesh for filter medium; but an aligning device for a fabric medium was still lacking. Inasmuch as the available aligning devices all worked on the principal of adjusting the parallelism of two axes, they all resulted in stretching the edges of the belts and all suffered because of the tendency of cloths to shrink or stretch differentially.

Recently, an aligning device which utilizes a longitudinally split pulley was perfected. One segment of this pulley is articulated. Power for movement is supplied by compressed air controlled by solenoid valves. When a sensing device indicates that belt alignment correction is needed, the articulated segment is shifted in the appropriate direction and a short section of belt is shifted over. Such positive correction has resulted in almost perfect control of the belt. Now, for the first time, it is completely feasible to have a drum filter with a constantly removable and replaceable cloth filter medium. Cakes as thin as 1/16 of an inch are easily discharged. The cloth can be washed and kept clean at all times.

Discharge methods on both drum and disc filters have improved. The application of the snap blow device on disc type filters has resulted in both cleaner discharge and lowered bag costs. At New Jersey Zinc Co. a snap blow on their zinc concentrate filter reduced bag consumption 22 percent. The use of roller discharge on disc filters for sticky thin cakes has reduced capital costs by allowing the use of disc filters in place of drum filters.

**Fig. 5. Coarse, fast settling solids filtered under conditions of properly directed agitation. Note even cake thickness which denotes uniform solids distribution.**

On drum filters the operation of the roll discharge has benefited by the development of adjustable scrapers (figure 3). Such applications have been widely made on flocculated slimes as in uranium yellow cake and kaolin clay.

The field of agitation in filters has been subjected to much study. The utilization of variable speed drives has provided flexibility not previously obtainable. Attention to this detail can result in higher capacity and lower cake moisture content. Investigation has also shown the importance of properly directed agitation. Figure 4A and C shows the ill effects of improper direction, while figure 4B shows the effect of properly directed agitation. Figure 5 shows a disc filter cake formed under proper conditions of agitation.

There are other advances in filtration not mentioned by virtue of either lack of knowledge or seemingly lesser importance. The above comments are intended only to summarize the most notable improvements in filtration.

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**A-C UNDERGROUND POWERS**

*(Continued from page 63)*

desirable where hazards to the cable connecting the load (trailing cable) are at a minimum and highest standard of repair procedure is practiced. For example, such a cable would be impractical on a shuttle car.

Ground Current Transformer:
Ring type transformers afford sensitive measurement of the ground fault current. The phase conductors are carried through the ring and the sum of the phase currents (even though loading is not balanced) is zero except when a phase wire is faulted to the ground.
Under fault some current flows in the ground wire and outside the ring. Phase currents are then unbalanced by the value of this ground current and the ring transformer secondary flows current proportional to the ground current.

Ground Check Devices; Ground Circuit Testing:

1. In most cases such equipment would be impractical when the job of cable repair is analyzed.
2. Frequent testing of ground continuity (to rated ground current value) should be made mandatory since system safety depends on continuity of the ground wire.

#### A-C Power for Illumination

1. Control transformers on mining equipment can be provided with windings for low voltage lighting; 6, 12, or 32 volts. Experience with the heavier filament lamps shows reductions in replacement costs on the order of 75–80 percent.
2. Single phase a-c power with safety ground, 120 volts or 240 volts, can be provided at the power center—
   a. This power could be used to operate small power tools for section maintenance; or
   b. For local fluorescent or incandescent lighting.

# 3 New International® Earthmovers

**new** CAPACITIES (24 yd. scrapers, 27 yd. wagon)

**new** POWER (375 hp)

**new** SPEEDS (to 29.1 mph)

Higher speeds possible with optional equipment.

## International 24 cu. yd. 295 Payscraper

Heaped: 31 cu. yd.
Overall length: 44'8".


**New high visibility color.** Optionally available on all three models in either Federal yellow or International Harvester red.

**NEW** positive push-type ejection assures quick clean dumping of all materials.

**NEW** advanced lift frame construction with A-frame-type gooseneck that: 1) increases visibility; 2) distributes weight evenly along cross tube; and 3) protects sheaves of bowl lift system.

**NEW** full 90° turns with power steering.

**NEW** 375 hp DT-817 turbocharged 6-cylinder diesel engine. See page 4.

**NEW** cycle-shortening haul speeds to 26.2 mph plus unmatched maneuverability.

**NEW** exclusive tapered bowl. See next pages.

**NEW** high 98" apron opening. See pages 2-3.

**NEW** automotive comfort and control features ... 16-adjustment bucket seat ... reach-easy controls ... unobstructed vision ... air brakes ... flush deck.

**NEW** Model 280 cable control unit ... fingertip control ... fast acting ... high capacity ... simple adjustments ... less maintenance.

See 3-axle models on inside pages...

# 27 CU. YD. International 495 Paywagon®


**Heaped: 40.5 cu. yd.**
**Payload: 40.5 tons.**
**Overall length: 50'4½".**

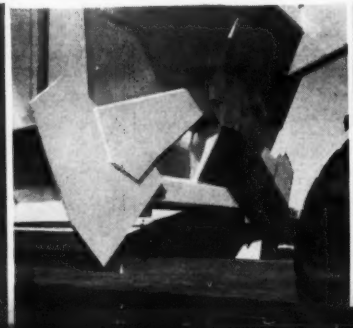
Here in the 27 *cu. yd.* International 495 Paywagon is everything that's new and productively *different* in bottom dump design. New 375 hp engine for greater power *per struck yard than any comparable rig.* New higher side and rear end clearance to roll away from any dumped load. New power-opened clamshell doors for positive controlled dumping. New wiper plates put 100% of each load on the fill. New automotive comfort and control features *that* let the operator produce more with less effort. New full 90° turning in either direction. New low design for haul road stability.

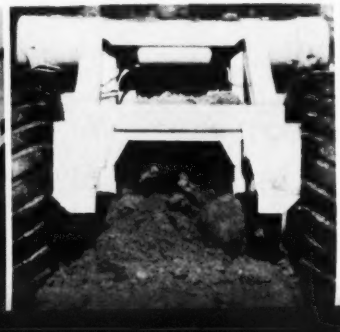
**New exclusive power-opened clamshell doors** afford positive controlled dumping. Operator spot dumps entire load or windrows material in lifts from a few inches on up. Wiper plates shave all material from doors as they raise. Doors gravity close, eliminating complicated mechanism.

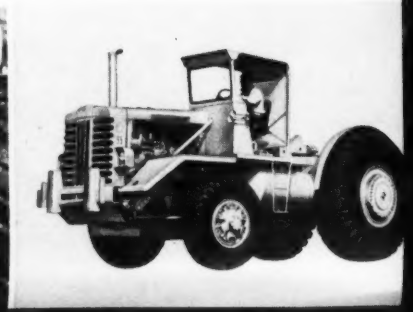
**Unmatched 60" rear end dumping clearance** lets rig pull fast from fill with no dangling doors dragging on dumped material. Open rear frame lets loader spillage fall through — prevents buildup of "free loading" material.

**375 HP 495 prime mover** gives both 495 Paywagon and 495 Payscraper more hp per struck yard with less gross weight per hp than any similar sized earth mover. Speeds to 29.1 mph. 10'8¼" wheel base. Full 180° non-stop turns can be made within 39'11¾".

## NEW high speeds big capacities



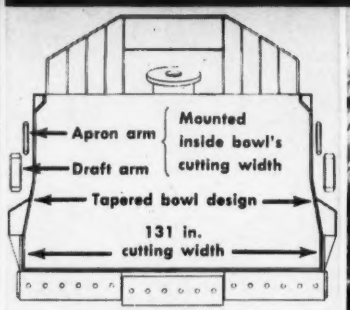


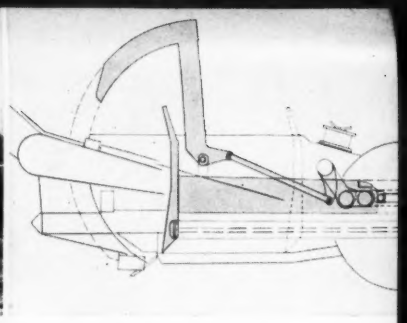


# big capacities

# fast dumping

# unmatched control



This new International 495 Payscraper boils a heaped load into a 24 cu. yd. bowl in less time than any other three-axle scraper in its class and hauls it at speeds up to 29.1 mph. The trailing unit, common to the 295 Payscraper, offers this unmatched combination of features that cut dirt costs: big 131-in. cutting width . . . tapered bowl permits efficient ejection of all materials with equal ease . . . positive forced ejection . . . improved lift frame construction . . . full 90° turns . . . more hp per struck yard than all competitive units . . . wheels and bowl leveling adjustment . . . advanced sheave bearing design . . . and custom designed cable control unit.

**Exclusive tapered bowl design:** 1) permits scraper and pusher to work inside cut for best traction, less wear on tires, and tracks, 2) causes dirt to boil toward center, reducing side spillage; 3) extra wide bowl bottom provides wider spread, speeds dirt breakaway and lets scraper work cuts against banks.

**Positive forced ejection** dumps all materials — even wet or frozen clay and gumbo — cleanly and quickly. Six large ball bearing mounted rollers center and guide ejector gate, have 240-hour lube intervals.

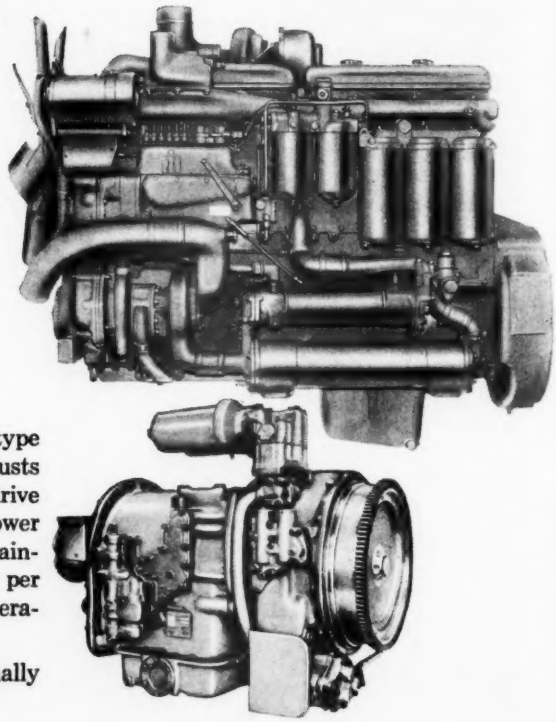
**Gaping 98" apron opening** plus no bowl cross member permits sure ejection of all materials. Apron opened by exclusive, rear-controlled mechanical linkage. Apron is synchronized with ejector for positive controlled spreading.

## 24 CU. YD. International 495 Payscraper

**Heaped: 31 cu. yd.**
**Overall length: 50'6¼".**

# New Turbocharged International DT-817 powers all three giant earthmovers

- Develops 375 hp @ 2100 rpm
- Direct push-button, 24-volt starting
- Positive valve rotators — increase valve life
- Aluminum alloy pistons for fast heat dissipation
- Wet sleeve construction provides additional cooling
- Fully counterbalanced crankshaft for smooth engine performance
- Dual intake and exhaust valves for peak engine efficiency
- Twin plunger injection pump precision meters fuel
- Hang down type replaceable filters for maximum fuel and oil filtering efficiency
- Tri-metal crankshaft bearings for long trouble-free service



Both prime movers are available with 4-speed, planetary type torque converter power shift transmission. It automatically adjusts output torque and speed to fit load requirements. Torqmatic drive makes more power available over the entire range; applies power smoothly and continuously, resulting in less wheel slippage; maintains high tractive effort; and cuts the number of gear shifts per cycle, letting operator concentrate on loading and spreading operations.

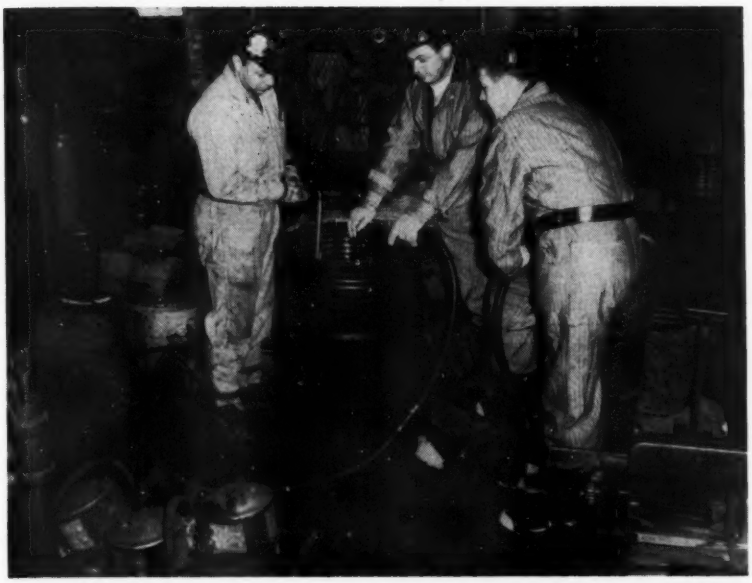
A constant mesh 9-speed manual shift transmission is optionally available on both prime movers.

**See your International Construction Equipment Distributor for complete information on these NEW International Earthmovers**

*International*® *Construction Equipment*

**International Harvester Co. • 180 N. Michigan Ave., • Chicago 1, Ill.**

A COMPLETE POWER PACKAGE: Crawler and Wheeler Tractors . . . Self-Propelled Scrapers and Bottom Dump Wagons . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.



Mixing fire-resistant fluid at a large West Virginia mine. As the oil is agitated with air, drinking water is slowly added. This is the most critical step in blending the fluid. Water must be added *slowly* to ensure a satisfactory emulsion

By

**A. S. MORROW**

Senior Engineer,
Industrial Application Department
Shell Oil Co.

**A cooperative program spearheaded by the U. S. Bureau of Mines has resulted in an economical fire-resistant hydraulic fluid for coal mine applications. Proper use of this water-in-oil emulsion can mean improved safety, less down-time and increased production**

# Fire Resistant Hydraulic Fluids for Coal Mines

Duquesne Light Co. tested F-R fluid in a shuttle car modified to handle the emulsion and found over-all performance good. However, the company did find it necessary to install an auxiliary 15-gal tank to keep bulk fluid temperature below the 150°F temperature found to be optimum for emulsions to prevent water loss

SAFETY underground is the concern of all those who are involved in coal mining: operators, mine workers, mining associations and institutes, Federal and State bureaus and departments of mines, and equipment builders and fluid suppliers. All of these groups work cooperatively in many ways to improve safety in the mines. One of the cooperative programs now underway is the development and application of fire-resistant hydraulic fluids for coal mining equipment.

## One Gal of Oil Consumed per 25.2 Tons of Coal Mechanically Mined

Some years ago the U.S. Bureau of Mines recognized the fact that, with

the expanding use of hydraulically actuated machinery in the mines, increasing volumes of flammable hydraulic oil were being taken into the face regions. This meant that hazardous conditions existed and would possibly increase in the future. As a result of a preliminary investigation, the Bureau, in early 1956, established a program to encourage the development of less flammable or fire-resistant hydraulic fluids, which could directly replace the hydraulic oil used in mining equipment. This program, under the direction of W. D. Walker, was most ably carried out by S. P. Polack.

The reasoning behind the program is self-evident when the following data collected by the Bureau and reported by Polack is reviewed.

| | |
|---|---|
| Total number of fires investigated involving hydraulic equipment 1952–1958 (8 Mos.) | 59 |
| Number of mines | 54 |
| Number of underground employees | 13,799 |
| Daily production, tons | 162,377 |
| Hydraulic oil capacity of equipment involved, gal | 3,046 |
| Ignition sources, electrical | 96.62% |
| Ignition sources, other | 3.38% |
| Hydraulic oil involved in fires | 72.88% |
| Losses: manpower, production, equipment | ? |

Further, it is reported that approximately one gal of hydraulic oil is consumed for every 25.2 tons of coal mechanically mined. This amounts to about 15,000,000 gal per year—a sizable volume of flammable material to have below ground. It is estimated that within ten years this volume could be doubled; hence, the problem could become even more acute.

The Bureau's program began with discussions of the problem with mine operators, mine workers, pump and equipment builders, and fluid suppliers. From these talks it was determined that a fire-resistant mine fluid should:

Be safe
Be easily handled
Directly replace hydraulic oil
Minimize hydraulic system modification
Be considered non-toxic
Be economical

## Water-in-Oil Emulsions Most Closely Fit Needs of Mines

The various types of fire-resistant fluids that have been commercially available for a number of years and have proven very satisfactory for industrial applications were considered. Among these are:

1. Phosphate ester
2. Phosphate ester base
3. Water/glycol
4. Water-in-oil emulsions
5. Soluble oils—oil-in-water emulsions

Of the five, the first three materials could be used in existing mining equipment if various system modifications were made depending on the type of fluid. However, in addition to the equipment modification costs, the initial cost would be 10 to 15 times that of hydraulic oil. The last type of product (soluble oil) would be used only if pumps, valves and cylinders were replaced. This leaves the water-in-oil emulsions as the type of product which most closely fits the needs of the mines, economically as well as functionally.

The water-in-oil emulsion type, fortunately, has had extensive development and satisfactory performance in many types of industrial hydraulic equipment. As a result, groups working on this program and with this background knowledge and experience have devoted most of their time and effort to the development of emulsions for mine applications.

## Oil Lubricates, Water Acts as "Snuffer"

What are these emulsions? They are premium hydraulic oils combined with certain emulsifying agents and water, by a definite procedure. The result is a water-in-oil emulsion—wherein the oil surrounds the minute water globules. Oil is the continuous phase, providing satisfactory lubrication, while the water acts as a "snuffer." When the fluid is heated to the ignition point, steam is evolved, thereby preventing combustion and subsequent fire. Repeated laboratory tests and actual industrial accidents have shown the emulsions to be satisfactory fire-resistant materials. However, it must be fully understood that if by accident or negligence water loss is excessive the fire-resistance is degraded. Even so, the hydraulic system will continue to function properly. This property of an emulsion should be remembered.

Emulsions can be provided at the mine in two ways. The first is for the fluid supplier to furnish a finished product—i.e., material is blended with the required percentages of oil and water. Here the supplier can guarantee quality and conformity of product at time of shipment. But he cannot guarantee the stability or quality of the emulsion after it has been in outdoor winter storage for an extended period of time. This may result in a machine being charged with material that is unsatisfactory, which may be followed by equipment failure.

The other method is to ship an emulsion concentrate to the mine, at which point drinking water can be mixed with the oil as recommended by the supplier. This method allows the concentrate to be stored outdoors, permits mixing of small batches when required and reduces the cost of the finished product. This latter method is considered the best possible compromise for mining applications.

## Fluid Developed, Evaluated

With these parameters in mind, a material has been developed that has the following typical properties:

| | |
|---|---|
| Water-in-oil emulsion | 60% Oil/40% Water |
| Specific Gravity | 0.9165 |
| Color | White |
| Neutralization No. | 0.12 |
| Specific heat @ 100°F | 0.68 |
| Coefficient of expansion | 0.0003 |
| Viscosity @ 40°F, SSU | 2180 |
| Viscosity @ 100°F, SSU | 367 |
| Viscosity @ 180°F, SSU | 98.5 |
| Viscosity index | 144 |

Preliminary evaluation of this fluid in a vane-type pump under varied conditions indicated that satisfactory performance could be expected.

Tests performed (by Shell Research) in a vane pump for varying hours and pressures but at a fluid temperature of 150°F had the following results:

| Hours | Pressure | Total Weight Loss, MG. | |
|---|---|---|---|
| | | Vanes | Ring |
| 304 | 1,000 | | |
| 304–556 | 1,200 | | |
| 556–756 | 1,500 | 64 | 193 |

It must be pointed out that these values are for one pump and at pressures in excess of the 1000 psi recommended by the manufacturer. Even so, the results are excellent and compare favorably with those found for other F-R fluids.

With the completion of these tests, the material was evaluated by the Bureau of Mines, U.S. Steel Lubricants Testing Laboratory and by Jeffrey Manufacturing Co.

The Bureau of Mines test, which will be reported in detail by Polack, consisted of operating the fluid in a test stand equipped with a widely used gear pump for 500 hours at 150°F and at 1000 psi, and for 500 hours at 185°F–190°F and 1000 psi. At the termination of the test the fluid was in relatively good condition while the pump (which was evaluated by its manufacturer and an equipment builder) was considered satisfactory

for further operation. Water loss of the fluid was seven percent of the total, even after the high temperature test period.

U.S. Steel's test was run in a test stand equipped with a vane pump for 1000 hours at 150°F and 1000 psi. Pump part weight loss was 0.0614 percent, which was the lowest encountered to date with any of the low-cost fire-resistant fluids.

Piston heads and the thrust plate against which they bear were pitted slightly and inside surfaces of the thrust bearing were fretted on the pressure side. This same condition has been found when testing several other fire-resistant hydraulic fluids. However, this did not occur in a similar test using petroleum hydraulic oil. Reasons for this type of surface fatigue are being investigated. Consideration is also being given to further work.

Other pump tests using various types of pumps are underway and will be reported in due course.

### Fire Resistance of Emulsion Meets Standards

The fire-resistance of the emulsion was investigated by Shell Research, Factory Mutual Laboratories and Bureau of Mines. In high pressure spray tests, using a neutral oxygen/gas flame or butane torch as an ignition source, the fire-resistance of the fluid met the standards established by these organizations. For example, in the Bureau test with the fluid at 150°F and 150 psi, there was no ignition and naturally no flame propagation at distances of 3 to 36 in. from the nozzle. At 3 in. there was slight ignition. Likewise, using an electric arc, there was no ignition from 18 to 36 in. In another test the fluid was heated to 140°F and, at 1000 psi, ejected through an 80° nozzle. With an oxy-acetylene torch only intermittent flashing was noted at 18 in., and nothing at 36 in. These results compare favorably with those found for "supplier furnished" emulsions and with other types of fire-resistant fluids.

### Field Trials Indicate Good Over-All Performance

With the results of the laboratory tests clearly indicating that a fire-resistant fluid could work in certain mining equipment, full field trials were arranged with a large coal company in the Fairmont field of West Virginia, and with Duquesne Light Co., Harwick, Pa.

At the West Virginia mine a Joy 10RU cutting machine was selected at random for the trials. The concentrate was shipped in drums to the mine.

For mixing, a clean open end 55-gal drum was used. In the bottom of the drum was placed a loop of pipe in which had been drilled small holes. An air line was attached to the pipe and clean shop air at low pressure (5–10 psi) was used for agitation. Thirty gal of the oil were poured into the drum and the air turned on. With the oil being agitated, 20 gal of drinking water were slowly added to the oil. This is the most critical step in blending the fluid. *Water must be slowly added to the oil* to ensure a satisfactory emulsion. After the water has been added—approximately 15 minutes duration—agitation was continued for an additional 45 to 60 minutes so that the water was completely mixed in the emulsion.

**An estimated 15,000,000 gal of hydraulic oil is consumed each year by equipment in the Nation's coal mines**

The 10RU hydraulic system was then drained of all hydraulic oil and 75 gal of F-R fluid charged to the reservoir. The machine was then run for about three hours, periodically using all circuits. At the end of this flushing period the fluid was drained and a new 75 gal charge placed in the system. A new double gear pump was then installed for purpose of the test and the unit returned to the face. The first cutting was done on January 14, 1959.

Since then the performance has been followed very closely. Make-up rates are about 50 percent of the system capacity per month. The bulk fluid temperature had not been found to be over 140°F, even after 12–14 cuts have been made, and water loss is negligible. To date the machine has made about 700 cuts, with the operators stating there is no difference in machine performance than found when operating on hydraulic oil.

One observation made has been that the degree of cleanliness found in this system is excellent. The maintenance men have been instructed to be particularly careful when adding fluid, and since they are using capped five-gal containers which are filled in the shop, the amount of coal and lime dust filtering or falling into the system has been minimized. This will be a problem when using fire-resistant fluids, and will require continual supervision.

The Duquesne Light Co. trial is in a Joy 5SC shuttle car modified to handle this fluid. A preliminary investigation of temperature conditions with oil showed that bulk temperatures rose to 185°F with the pump "dead-heading" and the car idle. With the car operating, the temperature dropped to 160 to 170°F. This, naturally, was far in excess of the 150°F top temperature found to be optimum for emulsions to prevent water loss. In discussing the system, circuits, flow rates, etc., it was found that the pump was rated at 18–22 gpm while the entire system capacity was only five gal. A decision was made to install an auxiliary 15-gal tank in the space formerly occupied by the power take-off. This auxiliary tank (built by the mine maintenance group from available materials) was tied directly into the existing tank.

Fluid at this mine was blended in the above manner but using a small centrifugal pump for agitation. Fluid was charged to the system and the car went into regular operation on January 15, 1959. The bulk fluid temperature was closely checked during the first week and at no time was it in excess of 105°F. After operating one week the fluid was changed and the operating charge installed. A new pump was also installed, for test purposes.

Some problems with pumps, and venting of the new tank have been experienced, none of which were attributable to the fluid. These have been corrected. One pump was changed, when the fluid was contaminated with oil. However, since February 4, the system with fluid temperature of 105°F has performed very satisfactorily while accumulating some 500 operational hours.

### Points to Consider in Handling Fluid

With these two mine tests indicating over-all good performance, it ap-

pears that an economical fire-resistant hydraulic fluid has been developed for use in the mines. However, it must be appreciated that these fluids are not identical to oils and therefore must be handled in a somewhat different manner. Thus, if, after discussion with the equipment builders and the fluid suppliers, it is decided to change a unit over to a fire-resistant fluid, the following points must be considered. For example, the fluid concentrate can be stored outdoors, but if stored in drums they should be protected from the weather. Rack the drums on their sides or upside down. In the winter, preparatory to mixing the emulsion, bring the drums indoors and allow them to reach shop temperature. This will permit more rapid pouring and greatly facilitate blending.

When blending, make sure the equipment is *clean*. Pour the proper volume of concentrate into the mixing container—*60 percent of the final blend*. Start the air, or pump, before adding water. Add (very slowly) clean drinking water—40 percent of total blend. After all the water has been added, continue mixing for an additional period—to be sure all the water is blended into the oil. When the emulsion is made, transfer it to a covered or sealed container. Again make sure the containers are clean and dry. The fluid in storage should be agitated before using. That in drums or tanks can be mixed with air; if in cans, by shaking. Above all, *do not store the emulsion where the temperature will fall below 40°F.* Cyclic freezing and thawing have an adverse effect on emulsions.

The application of emulsions in the equipment necessitates proper cleaning of the hydraulic system. Consequently, a flushing charge should be operated in the equipment for three to five working days to insure complete removal of dirt, debris, old oil, etc. Emulsions have excellent cleansing action and as a result will remove debris that oil will not touch. At this point all seals and components which are affected by water, such as cork and leather should be replaced by water-resistant materials. Filters, if installed, must be of the metal edge or screen type.

Once the fluid is in the clean hydraulic system, every effort should be made to keep the fluid from becoming contaminated. Proper operating temperatures should be maintained. Periodically, samples should be drawn from the system and checked for water content and contaminants. The sample must be representative of the system, and be taken in a clean bottle or can. For water determination, there are a number of acceptable methods—e.g., distillation, centrifuging and solvent extraction. In any case the fluid supplier can provide the proper method to be followed for the fluid which is in use. Water content should not be below 32 percent nor over 45 percent. As to debris, the bulk of it will be at the oil/water interface after the emulsion has been broken. Considerable debris is an indication that the fluid should be either filtered or changed.

These foregoing points may appear to be detailed, time-consuming and costly. Actually they are nothing more than good maintenance practice to obtain optimum hydraulic system performance. It is considered that, if they are followed, a fire-resistant hydraulic fluid can be used quite satisfactorily in the mines. The result will be improved safety, less down-time and, naturally, increased production.

# TRAINING YOUNG ENGINEERS

**The Engineering Training Program at Oliver Iron Mining Division is a major contribution to management development. Oliver has found that the transition from academics to industry is best bridged by employing new engineers in a variety of carefully prescribed assignments under the guidance of experienced and helpful personnel**

By

**R. O. HAWKANSON**

**Vice President—Administrative**
**Oliver Iron Mining Division**
**United States Steel Corp.**

THE Oliver Iron Mining Division, United States Steel Corp., is the major supplier of iron ore to U. S. Steel's northern furnaces. The Division's headquarters are located in Duluth and operations are centered in three operating districts located on the Mesabi and Vermilion Iron Ranges of northern Minnesota.

Present operating units consist of two underground mines on the Vermilion Range, ten large open pit mines on the Mesabi Range, together with seven ore beneficiating plants of various types which serve these mines. In addition, the Division operates a large experimental taconite mine and taconite concentrating plant, together with facilities for sintering and nodulizing the taconite concentrates. In an average year the Division employs about 6500 people and handles 75,000,000 to 80,000,000 gross tons of ore, rock, surface stripping and other materials.

Oliver's interest in increasing the professional competence of its engineering personnel has been stimulated by the changes which have taken place in operating and technical problems. These changes derive principally from the furnace operators' demands for ores of higher iron and lower silica content. This condition, together with the taconite development program, has made mining and processing problems much more complex, which in turn has made it imperative that Oliver's engineering selection and training programs provide the company with engineers of the highest degree of professional competence.

### Recruiting Requirements Planned Well in Advance

For these reasons the Division has for the last ten years engaged in a formalized recruiting program involving annual visits to as many as twelve colleges and universities. The objective of these visits is, of course, to find exceptional young men, trained in the fields of mining, metallurgical, mechanical, electrical, and industrial engineering, and geology. In the course of the same visits, graduates in chemistry, accounting, industrial relations and other business administration fields are recruited. Since the inception of the college recruiting program in 1948, 195 engineering trainees have been recruited from 19 colleges and assigned to the Engineering Training Program.

A question frequently asked is, "What determines the number of recruits sought for the training program in a particular year?"

Oliver, like many other organizations, plans its operating and facility needs several years in advance. Such a program involves planning with respect to probable production, available mineral, and necessary equipment, plant facilities and manpower. Equally important, however, is the fact that this advanced planning of operating and manpower requirements provides a basis for forecasting the needs for technical, supervisory and administrative personnel.

Each engineering department head and each district general superintendent submits an annual requisition for engineering personnel to be recruited, the number being based on the long range plan of the department, together with anticipated retirements, deaths, transfers, etc.

These requisitions are then summarized by the types of engineers required and submitted for review and approval of a top level Recruiting and Training Committee. The total requirement as submitted is adjusted by this committee in the light of their knowledge of division-wide personnel needs and probable long range Division activities.

Following approval of the requirements, recruiting teams composed of operating, engineering and personnel representatives visit selected engineering schools in the midwest and western states. The Division has attempted to maintain diversity in the selection of the schools from which its engineers are selected, on the theory that a variety of educational backgrounds

stimulates a sharing of viewpoints within the engineering and operating force.

Pamphlets and brochures describing the company and its operations and training program precede recruiters' visits to the schools. Students who are interested are scheduled for interviews, after which discussions are held with faculty representatives to develop information pertinent to the selection of students who will best fill the predetermined vacancies.

Final determination as to which engineers will be offered employment is made by the manager of personnel and the interested department head.

### First Step is Orientation Week

The training program to which the engineers are assigned upon completion of their scholastic work is administered by the Division's Industrial Relations Department and begins with an orientation week which is held soon after all of the engineers have reported to Duluth. During this week the trainees are taken on tours through at least one of each type of mine, plant and shop which Oliver operates. During this week they also tour other facilities in the area, which are directly associated with the production, shipment and processing of iron ore; such as a steel mill, railroad operations, and lake vessel loading facilities.

Orientation week serves to acquaint the trainees with each other and affords them an opportunity to meet various executives and departmental and operating supervisors throughout the Division. Meetings are held during this period at which time various department heads outline the functions and responsibilities of their respective departments for the trainees.

Following orientation week, each trainee is assigned to one of the three operating districts to begin his training. While in a particular district the trainee works under the direction of the district superintendent, but throughout his training program he remains on the General Office Training Department payroll. The retention of these employees on the General Office payroll is important for two reasons:

First, no district or department to which he may be assigned acquires a "vested interest" in the man. In other words, the General Office Industrial Relations Department retains control, in order that the training and ultimate placement of the trainee may be handled in a manner which best fits the needs of the Division as a whole. Secondly, since the district or department is not being charged with the trainee's salary, responsibility heads can schedule his traning assignments within the department without undue concern for the cost effect.


**At the time the engineer is given his training schedule, he is also informed of what he is expected to cover while in training at each department, mine or plant. Shown above, a trainee in the Maintenance Department finds there is much more than work scheduling and production control to think about. Time spent in actual repair and upkeep of shovels, diesel locomotives, trucks and other heavy equipment emphasizes the need for good maintenance**

### Training Schedule Has Definite Goals

The Training Staff prepares a complete training schedule for each trainee assigned to an operating district. These schedules differ for the various types of engineers and may also vary with the experience and anticipated assignment of the individual. The trainee is given a copy of this schedule in order that he may correlate the phases of his training. Advance notice of training assignments also serves to minimize disruptions of the trainee's personal life, since the Training Program, of necessity, requires the engineer to spend some time away from his place of residence. There are several considerations given to the manner in which the schedules are drawn. For example:

1. An attempt is made to have a trainee's first assignment be such that he will be able to see the greatest possible number of operations in his district, and to meet and make as many friends and acquaintances as possible.

2. Insofar as practical, an attempt is made to schedule training assignments in the same order that the material will flow. For example, in an open pit mining assignment exposure to drilling-blasting-loading-hauling-concentration-shipping, in that order, would be considered desirable.

3. The number of trainees assigned to any one responsibility at a given time is limited in order that those responsible for the training may devote maximum attention to the individual.

At the time the engineer is given his training schedule, he is also informed of the ground he is expected to cover while training in each department, mine or plant.

For the past two years the program has operated on a twelve month basis. During this period the trainee may be rotated through from ten to twenty assignments, varying in length from a few days to ten weeks. However, special programs for engineers with different educational backgrounds and experience may be established varying from six months to eighteen months.

A typical trainee schedule might be as follows:

1. *Safety* (2 weeks)—Learning the Division's safety program and its objectives.
2. *Mining Engineering* (14 weeks)—Performing the functions of rodman, transitman and mining engineer in connection with mine planning, production and reserve estimates, etc.
3. *Industrial Relations* (1 week)—Observing the basic functions of this department in connection with labor agreements, seniority procedures, grievance handling and scheduling.
4. *Mine Operations* (10 weeks)—To learn operating practices by assisting mine operators in the daily supervision of drilling


To help the engineer and the company make the best possible use of his talent — that's the goal of Oliver's Engineering Training Program

and blasting, shovel loading, and truck and rail haulage.

5. *Beneficiation* (9 weeks)—Working in washing, heavy media, crushing and screening, taconite concentration, and taconite agglomeration plants in both operating and maintenance assignments.
6. *Maintenance* (5 weeks)—Becoming familiar with the various repair shops and facilities, gaining knowledge of repair procedure, preventive maintenance, and equipment limitations.
7. *Construction* (3 weeks)—Performing as construction engineer or foreman on small jobs and construction inspector on larger construction projects.
8. *Engineering—Project & Design* (4 weeks)—The engineer works with this department in the field of plant, shop or equipment design, and appropriation handling.
9. *Industrial Engineering* (3 weeks)—Development of cost standards, the administration of the methods improvement and cost reduction programs, etc.
10. *Chemical Laboratory* (1 week)—Becoming familiar with laboratory and field procedures in the taking, preparation, analyzing, recording and reporting of ore samples.

When possible, training is accomplished by assignment to productive work. It has been found that training by pure observation, while necessary at times, does not hold the interest of the individual as well as actual work. Obviously, also, from an economic viewpoint, a working trainee is more of an asset than one who is not productive. Supervisors, under whom the trainees are working, are constantly encouraged to give the trainee responsibility for a job and the necessary authority to get the job done. On operating assignments the Division especially wants the trainee to perform the role of a supervisor.

Each trainee is required to prepare a report for each training assignment. The program does not require any particular form of report, but rather gives trainees these basic points to consider when writing the report:

1. A daily log of activities in the department is not desired. A report which ties the various elements of the training into a unit is preferred. The report should indicate the value of the training received and the areas in which additional emphasis should be placed.

2. The report should be accurate, interesting, and of value to those who will read it.

3. Supervisors appreciate any constructive criticism of their department and will put into effect usable suggestions.

4. The trainee is encouraged to discuss his report with the department in which he received his training before submission to the district training supervisor. This allows the supervisor to correct any wrong impressions the trainee may have received and, equally important, our supervisors do not have the feeling that reports concerning the activities of their department are being written "behind their back."

### Trainees Are Evaluated Individually By Supervisors

At the completion of each training assignment the supervisor is required to arrange an interview with the trainee. These interviews are conducted a few days prior to completion of the training, so that if it should develop that certain areas of training have been neglected, some time remains to eliminate this condition. During this interview it is the responsibility of the supervisor to determine to what extent the trainee has absorbed the training to which he has been exposed and to point out to the trainee both strengths and weaknesses he has demonstrated. It is the responsibility of the trainee to raise any questions he may have with respect to the particluar operation or the relationship that this operation or department bears to the remainder of the Division. These interviews are conducted in an atmosphere of complete informality.

Periodically, the trainee is interviewed by the district training supervisor, at which time his progress is reviewed. Here again the discussions are very frank and informal.

At the completion of each training assignment the individual responsible for the engineer's training completes a "Rating Report". On this form the supervisors are asked to rate the man with respect to being Above Average, Average, or Below Average, with appropriate explanations and suggestions for improvement and additional training. They are asked to record any adverse comments they may have with regard to the trainee and recommended action. Their opinion is requested as to whether the trainee is best suited for Engineering, Operations, or staff work, and the reasons for their conclusion. Finally, they are requested to indicate their attitude toward having this man permanently under their direction.

This rating report indicates that Oliver prefers to obtain the opinions of the supervisors in their own words, rather than through a checking system. These reports are not shown to the trainee at any time; although the district training supervisor utilizes these ratings in his periodic interviews with the trainee. The reports become a part of the permanent file of the trainee after he completes the Training Program.

(*Continued on page 79*)

# Operators' Corner

# TROLLEY WIRE LUBRICATOR*

Using the trolley wire lubricator, one man at the Ireland mine can lubricate five miles of wire in one hour

Designed by **E. P. McCARTNEY**
Maintenance Foreman
Hanna Coal Co.,
Ireland Mine, Division of
Consolidation Coal Co.

IN an effort to find an easier, faster, and more economical method of applying trolley wire lubricant, a unique method of applying lubricant with a motor-powered hydraulic pump has been devised at Hanna Coal Co. The system is essentially a closed circuit consisting of a lubricator reservoir, two globe valves, pump and motor. The line which carries the lubricant to the trolley wire tees off another line from the pressure side of the pump to the tank.

### Installation

The trolley wire lubricator can be put in any motor or personnel carrier, and can readily be moved from one vehicle to another as it only weighs 50 lb. All that is needed to make the lubricator operable is to hook the nip from the pump motor of the greaser to the harp of the vehicle being used, and run the lubricator line from the greaser along the trolley pole to the trolley wire. Wire greasing can be done at any time, either on shift or on an idle day. At Ireland mine the lubricator has been operated from the 50-ton haulage motor on shift and from an open type personnel carrier on idle shifts. The wire is greased every two weeks, which seems to give the company an economical balance between trolley shoe wear and trolley wire wear.

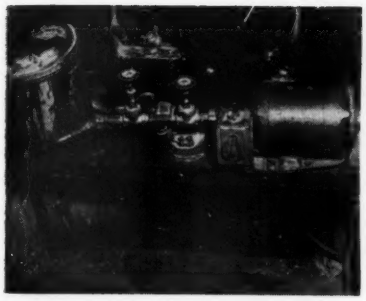
Arrangement of the component parts of the greaser is as follows. A two-gal tank with a removable top is used as a reservoir for the trolley lubricant. A ½-in. suction line comes out of the bottom of the tank and goes to a ¼-in. gear pump which is driven by a ¼-hp 1725 rpm d-c motor. The motor is controlled by a simple tumbler switch and the power supply for the motor is obtained by hanging a trolley nip on the harp of the vehicle being used. On the pressure side of the pump a ¼-in. line goes into a tee, thence into a globe valve on each outby leg of the tee. One leg of the tee is connected back to the tank and the other leg of the tee is connected to a ¼-in. flexible rubber hose which carries the lubricant to the trolley wire. This hose is taped to the trolley pole in such a manner as to direct the flow of lubricant at the bottom of the trolley wire directly ahead of the trolley shoe. A piece of copper tubing, fastened to a 1/16-in. grease button with the end cut off, is installed in the end of the flexible rubber hose as a nozzle. The motor, pump, reservoir and valves are mounted on a six-in. channel three ft long. The cost of the greaser is $108.00 for material and $30.00 for labor.

The flow of lubricant is directed at the bottom of the trolley wire directly ahead of the trolley shoe. Note the piece of copper tubing which is being used as a nozzle

### Operating Procedure

After the greaser is installed in the motor, jeep or portal bus as previously described, the following operating procedure is used. Incidentally, an open type jeep is the most handy conveyance to use when greasing wire. Trolley wire lubricant is mixed and put into the reservoir of the greaser. The globe valve controlling the flow of lubricant to the trolley wire is closed and the valve controlling the flow to the reservoir is opened. The pump motor is turned on and allowed to run for a short period to intimately mix the lubricant. Then the globe valve controlling the flow of lubricant to the trolley wire is gradually opened until the required amount of lubricant is delivered through the nozzle. If the flow is not sufficient when this valve is completely open, then the valve controlling flow back to the reservoir is closed gradually until the desired amount of lubricant is obtained through the nozzle. There will almost always be some lubricant being returned to the reservoir to keep the lubricant well mixed. The flow of lubricant to the trolley wire can be regulated so that when the lubricant

** Based on an article which appeared in the February issue of "Hanna Coal News."*



The 50-lb automatic greasing system employs a lubricator reservoir, two globe valves, hydraulic pump and motor—all mounted on a six-in. wide by three-ft long channel

is being applied to the wire almost any speed of travel can be used.

This method of lubricating wire is more economical than other methods because of the great savings in time consumed in applying lubricant. One man can lubricate five miles of wire in one hour. John Zitko, superintendent of Ireland mine, states that the lubricator is more efficient in preventing worn wire because it is never sacrificed for more pressing jobs; obviates special attention on the part of the supervisor; and human fallibility is eliminated to a large extent.

There are presently two of these lubricators in use. They are at the Ireland and Glen Castle mines of Hanna Coal Co., Division of Consolidation Coal Co. A patent on the lubricator has been applied for.

**Training Young Engineers**

*(Continued from page 77)*

As mentioned earlier, the Division attempts to pick men for predetermined openings; and the training is varied in accordance with probable future assignments. In actual practice, however, the "crystal ball" sometimes fails to accurately predict vacancies. Also, on occasion an engineer will either change his mind as to the type of work he thought he desired; or he may prove to have exceptional abilities in fields other than those for which he was slated. In these cases, of course, plans are changed to make the best possible use of the individual's talents.

In conclusion, it has been found that the transition between academics and industry is best bridged by employing the budding engineer in a variety of assignments, under the guidance of experienced personnel, so as to enable him and the company to build a sound basis upon which to decide the nature of his permanent assignment.


When you're talking about a $162,000 dipper shovel, you've got to talk about the best rope for it


Talking about or working with, the same thing applies. Anything below Royal Blue's performance level is simply unrealistic. Like looking for a cut-price brain surgeon.

Even at $162,000, the cost of wire rope is important. That's why so-so ropes can cost you more in the long run, because so-so ropes are *short run*. Royal Blue, on the other hand, is built by America's oldest manufacturer of wire rope to last, to do the job without a whimper. Here's why.

Royal Blue is made from the toughest rope wire ever made—Type 1105—extra high-strength improved plow steel. This pedigree gives to the rope qualities that you can't find in any other rope: exceptional resistance to shock, abrasion, fatigue and impact. Add to these a flexibility that age cannot wither nor hustling fade and you've got a collection of characteristics that make Royal Blue the strongest rope you've ever used.

A $162,000 Dipper Shovel deserves the best and your Roebling Distributor has it . . . Royal Blue. Any inquiries about this high-born rope will be answered immediately by Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

**ROEBLING**

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**As Viewed by HARRY L. MOFFETT of the American Mining Congress**

CONGRESS returned from its Easter vacation early in April and immediately ploughed into a heavy accumulation of legislative proposals. Committees on both sides of the Capitol are readying a number of major measures for floor consideration, particularly appropriations bills.

The Senate got into action with heated debate over the controversial Kennedy labor bill, while the House centered its attention on a number of minor measures.

Many members of Congress returned from a Spring respite determined to seek a solution to some of the problems being faced by the minerals industries. Particular attention is being given by both Senators and Representatives to the need for mineral policies to strengthen domestic lead and zinc production, maintenance of a virulent strategic metals industry, and a broad coal research program. What shape legislative proposals in these fields will take is as of yet uncertain.

A number of appointments of interest to mining have been made in the past few weeks including former Senator Frank Barrett of Wyoming to be general counsel of the Agriculture Department, Earl F. Hastings of Arizona as SEC Commissioner, and former Senator Arthur Watkins of Utah to be a legal consultant to Interior Secretary Seaton on water and power matters.

### SENATE TACKLES LABOR LEGISLATION

Probably the most controversial piece of legislation to reach the Senate floor so far this year is the Kennedy-Ervin labor-management "reform" bill which the Senate began debating April 15.

Supporters of the measure, including the AFL–CIO, claim that it is a "fair" answer to the problem of eliminating the sordid abuses of union power revealed by the Senate rackets committee, without harming legitimate unionism. Another faction—in which Senator Barry Goldwater (Rep., Ariz.), ranking Republican on the Senate Labor Committee, and Senator John McClellan (Dem., Ark.), chairman of the rackets committee, are leading figures—strongly disputes this view, asserting that the bill's wishy-washy provisions will have little effect on union racketeering and will fall far short of insuring effective protection for rank-and-file workers.

★ ★ ★ ★ ★ ★

## Washington Highlights

**LABOR:** Kennedy bill before Senate.

**UNEMPLOYMENT COMPENSATION:** Federal standards opposed.

**ANTITRUST BILLS:** In Senate committee.

**LEAD-ZINC QUOTAS:** Changes urged.

**FLUORSPAR:** Hearings held.

**OIL IMPORTS:** Controls under fire.

**COPPER RELEASE:** Opposed by Senate.

**PRICE NOTIFICATION:** Heavy adverse testimony.

**COAL RESEARCH:** Independent commission voted.

★ ★ ★ ★ ★ ★

The Kennedy-Ervin bill also contains several Taft-Hartley amendments, long sought by unions, which would permit prehire union contracts in the construction industry and permit replaced economic strikers to vote in representation elections, among other things. The first Senate vote on the bill came on a motion to strike these amendments; it was soundly defeated, 67 to 27.

The second vote was on a motion to substitute Administration-backed Taft-Hartley amendments for those just upheld by the Senate. Included in this proposal were curbs on organizational picketing and secondary boycotts; the motion was defeated 67 to 24.

As this is written, the Senate still has to consider more than 100 amendments running the gamut from precise minimum standards aimed at insuring democratic conduct of union internal affairs, to a genuine strengthening of the Taft-Hartley Act.

The final form of the bill passed and sent to the House will have to await the outcome of many hours of debate and voting.

### UNEMPLOYMENT COMPENSATION STUDIED

The House Ways and Means Committee has completed hearings on numerous bills proposing minimum standards for the Federal-State unemployment compensation system, and is now considering this legislation at closed meetings.

Under Secretary of Labor O'Connell urged the Committee to approve extension of unemployment insurance coverage to an additional 3.2 million workers and to increase the taxable wage base from $3,000 to $4,200. He also recommended, with respect to coverage, that the definition of "employer" in the Federal Unemployment Tax Act be amended to apply to all

persons who employ one or more persons and that employees of nonprofit organizations, now exempt, be covered. Ways and Means Committee Chairman Mills (Dem., Ark.) spoke out against the demands of organized labor for Federal standards which would fix the amount of unemployment compensation benefits and the length of time which they would be paid. Agreeing with Mills, O'Connell said that the amount and duration of the benefits should be left to the States as under existing law.

Meanwhile, the President has signed into law a bill extending the Temporary Unemployment Compensation Act of 1958 for three months to July 1, 1959. The new law covers unemployed workers who were eligible for supplementary benefits on April 1, but does not cover those who exhaust State benefits after that date.

### RENEGOTIATION ACT UP FOR EXTENSION

On April 27 hearings opened before the House Ways and Means Committee on legislation which would extend the Renegotiation Act which is due to expire on June 30.

The Defense Department requested that the Act be extended until September 30, 1961, and that the present law be amended to (1) add an additional factor—the efficiency of a contractor or subcontractor—to those which must be considered by the Renegotiation Board in determining excessive profits; (2) encourage contractors to reduce costs by permitting them to share in savings realized from such reductions; and (3) provide for appeal of renegotiation cases from the Tax Court to the U. S. Courts of Appeals.

AMC executive vice president Julian Conover urged the Committee, in considering the measure, not to make any change in the existing law which provides a mandatory exemption for mineral raw materials.

### FIGHT SEEN ON TVA BILL

Still to be cleared by the House Rules Committee is the controversial bill which would give the Tennessee Valley Authority the right to issue its own revenue bonds to pay for new generating capacity. As approved by the House Public Works Committee, the measure would (1) limit TVA operations to those areas now served by the agency except for six "towns" on the fringes, including Memphis; and (2) require TVA only to "consult" with the Treasury Department on the selling price and interest rates of the bonds.

When the bill gets to the House floor, it is anticipated that a fight will develop because the Administration feels that it should have some control over proposed issuance of TVA bonds.

### ANTITRUST BILLS STILL IN SUBCOMMITTEE

Proposed legislation which unduly hampers mining and other industries in the conduct of normal business operations—the O'Mahoney premerger notification and the Kefauver price discrimination bills—may have been favorably reported by the Antitrust Subcommittee to the full Senate Judiciary Committee by the time this issue of the *Journal* reaches its subscribers.

The O'Mahoney measure is similar to one which was approved last year by the full Committee but was not brought up for a Senate vote. Generally, it would require corporations to give 60 days' advance notice to the Government when planning mergers or asset acquisitions if the combined assets involved exceed $10 million. While the bill contains an exemption with respect to undeveloped or partially developed mineral, mining or timberland properties, the American Mining Congress has vigorously opposed it as an unneeded and burdensome addition to the present antitrust laws.

The Mining Congress also opposed the Kefauver measure, pointing out that it would throw a "monkey wrench" into traditional pricing policies of American industry which actually work out to the benefit of the country's consumers—a benefit which would be lost if industry might subject itself to legal penalties whenever it lowered prices to meet competition, as the bill generally would provide.

### LEAD-ZINC QUOTA CHANGE URGED

The lead-zinc import quota program placed into effect last fall by the President has not helped the domestic mining industry and should be revised, according to a special House subcommittee which made an inspection tour last month of the Tri-State mining district in Kansas, Missouri and Oklahoma.

Members of the subcommittee were Reps. Edmondson (Dem., Okla.), Randall (Dem., Mo.), and Chenoweth (Rep., Colo.), who reported to the full Interior Committee that lead-zinc mining conditions in that district are "just as bad" now as they were last fall. The Congressmen did not indicate whether their proposed revision should be aimed at lower import quotas or other means of reducing imports, such as import excise duties.

Almost simultaneously, Secretary of the Interior Fred Seaton told a news conference that he does not think that import quotas are needed at present on products fabricated from lead and zinc. But, he said, his Department is keeping a close watch to see whether these products are being imported to circumvent the lead-zinc quotas.

Near the end of April, the Senate Interior Committee revealed that it may hold hearings involving the whole lead-zinc situation when it takes up, some time this month, a bill by Senator Allott (Rep., Colo.), to aid domestic producers. Allott's measure would authorize the Government to make limited "stabilization" payments on lead and zinc ores or concentrates through June 30 of next year. The bill is similar to the Seaton plan which was before the last Congress.

### COMMITTEE CONSIDERS FLUORSPAR IMPORT CONTROLS

The Senate Interior Committee has under study an import quota bill aimed at providing relief for independent domestic fluorspar producers, most of whose mines are shut down because of their inability to compete in commercial markets with lower-priced imports. The measure, which gives foreign producers an initial annual quota of 335,000 tons of all grades—equivalent to about 85 percent of 1958 imports—may be acted upon by the Committee in the near future.

During hearings in April on the bill, Senator Allott (Rep., Colo), a co-sponsor, testified that he believes the primary purpose of the measure is to determine whether it is possible to find a formula, which might be adapted to other minerals, that will permit a sharing of our domestic market between domestic and foreign fluorspar producers, keeping in mind the necessity for maintaining a stable price structure.

Several other members of Congress and spokesmen for independent domestic fluorspar producers urged approval of the legislation as the fairest way to assure a certain amount of domestic production of the mineral.

Opposition was expressed by the Departments of Interior, State, and Commerce, who declared that administrative remedies—under which the President can take action to control imports as he did last year in the case of lead and zinc—have been estab-

lished by Congress in the Trade Agreements Act to take care of this type of problem.

Domestic consumers and importers also opposed the bill, stating that it would restrict sources of supply, increase costs of producing many products without any corresponding benefit to the rest of the economy, and "establish a dangerous precedent which would wreck the reciprocal trade program."

### OIL IMPORT CONTROLS ATTACKED

The mandatory controls on all petroleum imports, including residual fuel oil, which were established by President Eisenhower in March, have been attacked by eight New England Senators. The Senators have introduced a bill to rescind the President's action, claiming that the import restructions will "adversely affect New England's industrial growth, its competitive economic position and the welfare of its citizens." On the other hand, representatives of the coal producing states have pointed out that the program permits residual imports at the 1957 level—the highest in history—and that limitations on the growth of residual oil imports are essential to the economic revival of the coal railroad industries. There is very little chance that this year Congress will seriously consider any legislation interfering with the President's program.

### SENATE OPPOSES DPA COPPER RELEASE OF GOVERNMENT COPPER

In the wake of press reports in mid-April that the Government was contemplating the sale of nonstockpile copper in its inventories (estimated at 128,000 tons), the Senate promptly registered its opposition to such a move.

The Senate Interior Committee approved a resolution to let the Executive Branch of the Government know "without any question of doubt" that it is the sense of the Senate that release of any part of the copper stocks would not be in the best interests of national security.

In its report accompanying the resolution, the Committee noted the adverse effects of the press accounts on the price of copper and called on the Executive Branch "to announce immediately that it has no intention of ever releasing any of its copper inventories except in the case of a real national emergency." Release of any of these stocks, the resolution said, would result in "incalculable damage to the national security and economic well-being of the Nation."

The Senate passed the resolution April 17, one day after it was approved by the Interior Committee. Senator Barry Goldwater (Rep., Ariz.), who presented the resolution to the Senate, said he had received assurances that the Office of Civil and Defense Mobilization was not contemplating release of any copper at this time and that the whole question is under study at the White House.

### PRICE RAISE PRENOTIFICATION HEARINGS

A so-called "price hike prenotification" bill was the subject of hearings April 23–May 5 by the Senate Judiciary Antitrust Subcommittee headed by Senator Kefauver (Dem., Tenn). The measure would require corporations in heavily concentrated industries to notify the Federal Trade Commission 30 days in advance of an intention to raise prices. The FTC would hold hearings when the agency deemed it advisable, on the justifiability of the proposed price increases, but would not be given authority to control or regulate the prices. This would be left up to the force of public opinion. Leaders of industry, labor and government testified on the proposal.

The American Mining Congress strongly opposed the bill stating that it would be contrary to the principles of our free enterprise system and would be unfair and discriminatory as applied to the corporations affected.

Also considered by the Subcommittee was legislation sponsored by Senator Clark (Dem., Pa.) and Rep. Reuss (Dem., Wis.) calling for public hearings by the President's Council of Economic Advisers on price and wage increases by "pace setting" industries. A revised bill of that originally introduced by the two Members of Congress has also been approved by a subcommittee of the House Committee on Government Operations and is expected to receive the approval of the full Committee. However, as approved by the subcommittee, such hearings would be held by some Government agency designated by the President rather than by the President's Economic Advisory Council.

### COAL RESEARCH COMMISSION APPROVED BY SUBCOMMITTEE

A cherished project of the coal mining industry moved nearer to reality late in April when the House Interior Subcommittee on Mines and Mining approved a bill which would set up an independent Commission to conduct an expanded program of coal research and development. The full Interior Committee was expected to favorably report the legislation to the House, although the possibility existed that the bill might be amended to place the program under the Bureau of Mines, as suggested by the Administration.

The American Mining Congress and other coal industry groups have long supported stepped-up research to improve coal's position in our economy and to help assure a solid mobilization base to meet any future national emergency.

Last year a similar measure was approved by the Senate and the House Interior Committee, but it failed to reach the House floor for a vote.

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# personals

**J. Peter Grace, Clifton W. Phalen** and **R. Stuart Keefer** were elected to the board of directors of Kennecott Copper Corp. This action was taken to fill vacancies created by the retirement of **Henry S. Drinker, Henry O. Havemeyer** and **Alfred O. Sloan, Jr.** pursuant to the corporation's recently announced plan for director retirement.

J. P. Grace

C. W. Phalen

R. S. Keefer

Grace is president of W. R. Grace and Co. Phalen is at present executive vice president of American Telephone and Telegraph Co., but will shortly assume presidency of the New York Telephone Co. to which he was recently elected. Keefer is president of Okonite Co., Kennecott's wholly-owned wire and cable subsidiary.

The Mining Development Committee of Bituminous Coal Research, Inc., has appointed **James R. Garvey** of Columbus, Ohio, to the position of acting director of development of the Bituminous Coal Research Mining Development Program. He succeeds **Gerald von Stroh.**

The Hanna Mining Company's board of directors has been expanded from four to nine members. Newly-elected board members are **Herbert Hoover, Jr.,** consulting engineer; **Nathan W. Pearson,** vice president of T. Mellon and Sons, Pittsburgh: **William H. Moore,** chairman and chief executive officer of Bankers Trust Co., New York; **George H. Love,** chairman of Consolidation Coal Co., and **H. L. Pierce,** retired Hanna Mining vice president.

**Dennis A. Mooney** has been appointed superintendent of the Montcoal operations of Armco Steel Corporation's West Virginia coal mines. Mooney succeeds **A. E. Oakley,** who is retiring after 25 years with Armco.

The formation of Aston Mineral Engineering Service, a consulting association, has been announced. Consultants are **Charles (Chuck) Aston,** prominent petroleum geologist of Beverly Hills, Calif., and **R. Lee Aston,** mining engineer and geologist of Chattanooga, Tenn. **James Aston,** metallurgist, and a former AIME Hunt gold medalist, of Pittsburgh, Pa., will have a limited association. Mineral Drilling Service of Chattanooga will change its name to that of the new association. The consulting firm will maintain offices in Long Beach and Beverly Hills, Calif., Pittsburgh, Chattanooga, and Tate, Ga.

**W. Patterson Shoff** has been appointed president and **Porter Gillespie** vice president of the newly formed Pittsburgh and West Virginia Coal Co. The new company will be general sales agent for Christopher No. 5, Pitfair, Bostonia and other mines in both Pennsylvania and West Virginia.

**James E. Petersen** has been named director of industrial relations for Utah Copper Division of Kennecott Copper Corp., to succeed **Maurice Strittmatter** who resigned recently to return to engineering work.

**Chester D. Tripp,** president of Consolidated Coppermines Corp., has been elected a member of the board of directors of Cerro de Pasco Corp. Tripp's election preceded the consummation of the transaction by which Cerro acquired Coppermines' assets, property and business.

**W. A. Fannin** of Steubenville, Ohio, assistant to the president of National Steel Corp., has retired. Fannin began his career in the organization in 1930.

## CORE HEADS AMC DIVISION

**Jesse F. Core,** vice president—operations—coal, United States Steel Corp., has accepted the chairmanship of the Coal Division of the American Mining Congress. He succeeds **L. C. Campbell,** retired vice president, Eastern Gas & Fuel Associates.

Core, a graduate of Penn State, is well known in the coal mining industry. He began his career in 1935, serving as a miner and rising through the ranks to his present position. He served in various capacities with Hillman Coal & Coke, Consolidation Coal Co., Buckeye Coal Co., Island Creek Coal Co. and U. S. Steel Corp. He became chief engineer for the Frick District of U. S. Steel in 1954, general superintendent in 1955, and was appointed vice president of operations for coal in February 1958. As chairman of the AMC Coal Division, Core will lead the several Coal Division committees in their efforts to advance coal mining technology to even higher levels.

J. F. Core

L. C. Campbell served as head of the Coal Division for eight years. Under his leadership the Division contributed much to the advancement of mining technology and to the interchange of information which has enabled the industry to continually improve its operating efficiency. Retiring from his company late last year, he is now serving as a consultant with offices in Pittsburgh.

**Oscar S. Straus** became a partner in the mining and metallurgical firm of Guggenheim Brothers on May 1. Straus, who is a great-grandson of the founder of the firm, will be in charge of new projects, exploration and development. Guggenheim Brothers is a successor to firms of the same name that developed some of the world's leading mining and metallurgical enterprises.

He is resigning as chairman of the finance committee of American Smelting and Refining Co., but will continue as a director.

Appointment of **Lawrence B. Berger** of Pittsburgh, Pa., to head the Division of Health in the U. S. Bureau of Mines was announced recently. Berger, who will complete 40 years of service with the Bureau next November, will continue to make his headquarters at Pittsburgh, where he has been stationed throughout his Government career. He will direct the Bureau's studies of environmental health hazards in mines and plants of the mineral industries throughout the United States.

**James P. Haight,** vice president in charge of engineering and purchasing for Aluminum Company of America has retired following a 39-year career with the company.

**Harry F. Yancey,** a coal expert with the U. S. Bureau of Mines in Seattle, Wash., has been named "Seattle's Engineer of the Year," by the Seattle Chapter, Washington Society of Professional Engineers. Yancey, supervising engineer of the U.S. Bureau of Mines, has developed many ways to clean and process coal and has worked out grading methods which are industry standards.

Appointment of **Charles H. Dewey** as general manager of northern ore mines and of **Joseph R. McVicker** as general manager of coal mines was announced by Republic Steel Corp.

Dewey will supervise Republic's mines in Port Henry District, Mineville, N. Y. Chateaugay District, Lyon Mountain, N. Y.; the Tobin mine in northern Michigan, and the Susquehanna mine in northern Minnesota. McVicker will oversee the company's coal mines in Pennsylvania, Kentucky, West Virginia and Alabama and also will have charge of Republic's ore mines in Alabama.

Both succeed **E. B. Winning** who retired recently after 43 years service with Republic and 50 years in the mining industry.

**Carl S. Gommel,** manager of the Garfield, Utah, cobalt refinery of Calera Mining Co. has been transferred to Henderson, N. C., where he will build a pilot plant for extraction of silver values from tungsten ores produced there. Calera is a wholly-owned subsidiary of Howe Sound Co.

**Charles M. Shoffner,** well known in coal circles, will retire after 23 years as chief executive officer of Pittsburg and Shawmut Coal Co. and Allegheny River Mining Co. He will devote his entire time to his group of Ringgold companies engaged in coal production and sales in central and western Pennsylvania and northern West Virginia, and his various activities in Kittanning, Pa.

**John R. Rand,** state geologist of Maine since early in 1956, will terminate his contract with the State on June 30 to return to his private practice in geologic consulting. A director of Copper Range Co., White Pine Copper Co., and Big Sandy Co., Rand will locate his consulting office in Augusta, Maine.

**G. E. Sorensen,** president of Kemmerer Coal Co. and Gunn-Quealy Coal Co., of Frontier, Wyo., was elected president of the Utah-Wyoming Coal Operators Association. He succeeds **Walker Kennedy,** president of Liberty Fuel Co. **C. C. Cornelius,** general manager of United States Fuel Co., was elected vice president.

## OBITUARIES

**Harry G. Kennedy,** 55, executive secretary of the Kanawha Coal Operators Association, died March 25 at his home in Charleston, W. Va. Mr. Kennedy, a graduate of West Virginia University became associated with the Association in 1932 and had been Executive Secretary since 1943. In 1944 he served as labor consultant to Secretary of the Interior Harold Ickes.

Mr. Kennedy was a past president of the West Virginia Society of Professional Engineers, and a past vice president of National Society of Professional Engineers.

**Donald S. MacBride,** 65, president of American Cement Corp., died March 11 in Philadelphia after a short illness. He had resided in Villanova. Prior to becoming president of American Cement Corp., Mr. MacBride was associated with Hercules Cement Corp. for 20 years, serving successively as vice president for sales, executive vice president and president. When Hercules, Peerless Cement Corp. and Riverside Cement Co. merged to form American Cement, he was elected president and chief executive officer.

Mr. MacBride was a former director of American Mining Congress and Portland Cement Association.

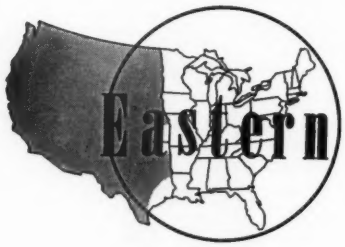
**Frank Harry Hayes,** 70, well known mining man, passed away in Tucson, Ariz., on March 29. Mr. Hayes began his career at Morenci, Ariz., upon graduation from Columbia University School of Mines in 1909 when he joined Detroit Copper Co. which later became the Morenci Branch of Phelps-Dodge Corp. In 1920 he was made assistant to the vice president and general manager of Phelps-Dodge Corp. at Douglas, Ariz., and in 1922 became superintendent of mines at Copper Queen Branch at Bisbee. In October 1931 he left the employ of Phelps-Dodge and served as consulting engineer on nonferrous metals.

During World War II, Mr. Hayes was assistant director of the Copper Division of War Production Board and later deputy vice chairman for metals and minerals; and throughout World War II served with distinction as chairman of the Premium Price Plan for copper, lead and zinc. After ending his War Production duties he was appointed Chief of the Metals and Minerals Division of the National Production Authority.

**Edgar Morgan Barker,** 50, died March 19 in Honolulu. He was vice president in charge of production for Calaveras Cement Co. Mr. Barker joined Calaveras in 1947 as manager of its San Andreas, Calif., plant. He held that position until his appointment as vice president in the company's San Francisco office in 1953.

Active in mining circles for many years, Mr. Barker was general chairman of the national convention of AIME, held in San Francisco last February.

# NEWS and views




### MCJ Receives Safety Award

***Mining Congress Journal*** was recently informed that it had been voted the National Safety Council's Public Interest Award for 1958. The Journal is proud to be one of the recipients of this award and wishes to express its sincere appreciation to the Council.

The noncompetitive award is made each year to public information media for exceptional service to safety. The 1958 award went to 39 daily and 14 weekly newspapers, 145 radio and 35 television stations, 3 television and 3 radio networks, 4 radio-TV syndicates, 14 general circulation and 44 specialized magazines, 7 labor publications, 50 advertisers and 70 outdoor advertising organizations.

A study of these 1958 Public Interest Awards shows the tremendous contribution of mass communication media to the sharp reduction in the number of accidental deaths last year, according to Howard Pyle, president of National Safety Council.

### Pittsburgh Steel Adds to Ore Reserve

Pittsburgh Steel Co. has substantially increased its ore reserves by acquiring, effective January 1, 1959, an additional five-ninths interest in Bennett Mining Co., three-ninths of which was formerly owned by The Youngstown Sheet & Tube Co. and two-ninths of which was formerly owned by Bethlehem Steel Corp. With this acquisition, Pittsburgh has increased its interest to seven-ninths, with Interlake Iron Corp. owning the remaining two-ninth interest. Bennett's properties are located directly north of Keewatin, Minn., on the Mesabi Range and in 1955 the company constructed a concentrating plant to treat lean ores.

### Asarco Will Close Alton Lead Smelter

The Alton, Ill., lead smelter of American Smelting & Refining Co. will close down in July after more than 50 years of continuous operation. Announcement of the closing was made by J. D. MacKenzie, Asarco's board chairman and president, who said that the notice of termination of the smelting contract between St. Joseph Lead Co. and American Smelting had made the step imperative. The import quotas on lead and zinc, imposed by the U. S. Government last October 1, were also a factor in the decision to close the plant, MacKenzie said, because the quota restrictions make it impossible to obtain an ore supply for the plant from other sources.

A custom plant, the smelter was built and equipped to handle high grade lead concentrates of the type produced in the southeast Missouri lead belt. St. Joseph Lead has been for many years its major customer. The output of the southeastern Missouri mines of St. Joseph can now be handled entirely by that company's smelting facilities. Notice of termination of the long standing smelting contract has consequently been received by Asarco.

### Two Coal Companies Propose Merger Move

A proposed merger of North American Coal Corp. and Warner Collieries Co. has been announced by presidents Henry G. Schmidt and Whitney Warner, Jr., respectively. The merger, subject to approval of both companies' stockholders, would be accomplished through an exchange of stock, with Warner stockholders receiving three fourths of a share of North American common stock for each Warner share.

North American has mines in West Virginia, Ohio, Pennsylvania and North Dakota, producing about 5,500,000 tons of coal per year. Warner's properties are located in West Virginia and Ohio and yield more than 1,000,000 tons a year.

Warner properties are complementary to North American's and give the latter company access to new markets. It is planned that Whitney Warner will be elected vice president in charge of all West Virginia operations of the merged companies.

### Copper Discovery in Missouri

American Zinc, Lead and Smelting Co. has discovered an important copper orebody in Missouri, according to a report on the company's exploratory iron ore drilling program in the Bourbon and Boss-Bixby area. The company revealed that its joint-venture drilling program with Granite City Steel Co. had uncovered ore in three out of 12 holes completed on approximately 5000 acres under lease and option at Boss-Bixby. The three holes gave promise of a commercial grade of copper ore, with thicknesses up to 100 ft. Four holes showed promising signs of copper mineralization. All holes completed have shown iron mineralization.

At Bourbon, eight holes have been completed, all of which indicate iron mineralization but not of commercial magnitude.

Due to the great depth of holes, drilling progress is slow. Ultimate average depth is from 1900 to 3000 ft.

The drilling program is continuing to determine whether the company has a commercial orebody deposit.

## New York Coal Price Cut

Joseph E. Moody, executive director of National Coal Policy Conference, recently announced a reduction to major industrial users of approximately 50 cents per ton on bituminous coal in New York harbor effective April 1. Similar reductions in coal prices for other Eastern Seaboard areas are in the process of negotiation.

The New York reduction represents decreases in prices averaging 25 cents per ton by both the producers and the railroads, and it brings delivered prices in New York in line with those in 1949.

Moody's announcement said that price decreases and other factors should set at rest fears that the President's recent order imposing mandatory quotas on residual oil imports will raise fuel prices in the East. The action by coal producers and railroads indicates a determination to retain Eastern markets by making coal attractive to consumers.

## Columbia Receives Large Bequest

A scholarship which defrayed the tuition fee of the late Henry Krumb when he was a student in the Columbia University School of Mines has prompted what is believed to be one of the largest single bequests in Columbia's 205-year history. The bequest, the immediate portion of which is expected to total nearly $6,000,000, may eventually amount to about $10,000,000.

Mr. Krumb, who was graduated from the Columbia School of Mines in 1898, died December 27, 1958, at the age of 83. He was one of the country's leading mining engineers, an active director of Newmont Mining Corp. and other important companies. His devotion to his profession and to the school which trained him for it was highlighted in a paragraph of his will.

"Some of the Eastern colleges have discontinued their mining departments for economy reasons," he

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wrote, "because the cost of educating a mining engineer is greater than that of some of the other professions, and also on account of the competition of mining schools in western mining states which are state-supported and consequently have low tuition fees. It is in order that Columbia will never consider abandoning its School of Mines that I am making these bequests."

### $8,000,000 Coal Mine Under Construction in Ohio

Nelms No. 2 mine, under construction three miles from Hopedale, Ohio, may cost as much as $8,000,000 and will employ 300 persons when full production is reached in 1960, according to Youghiogheny & Ohio Coal Co. of Cleveland, Ohio. The project is laid out so as to produce 1,000,000 tons a year, and the life of the mine is estimated at 35 years.

The company has sunk a 384-ft ventilation and personnel shaft and slope for coal and supplies. The shaft is concrete lined and has two compartments. The 30° slope extends 1400 ft and is also compartmented into two units. One section is for a belt conveyor 1500-ft long which will be capable of moving coal at a rate of 550 tph. The other section will contain track for transporting supplies and equipment.

Y. & O., which operates five mines, hopes to develop a European market as a result of the St. Lawrence Seaway.

### Buffalo Named Site of 1959 First Aid, Mine Rescue Contest

The 1959 National First Aid and Mine Rescue Contest will be held at Buffalo Memorial Auditorium, Buffalo, N. Y., October 5, 6, and 7, according to Marling J. Ankeny, Director of the U. S. Bureau of Mines. The contest is held every two years under sponsorship of the Bureau and the Joseph A. Holmes Safety Association and in cooperation with National Coal Association, United Mine Workers of America, State mining departments, local mining institutes, and coal operators' associations. Leading first-aid and mine rescue teams from various mining areas compete for congressional medallions and other awards.

**ALSO . . .**

**Texas Gulf Sulphur Co.** has been granted a five-year option on lithium mining properties in North Carolina. The option was granted by Basic Atomics, Inc. The agreement also includes a five-year option on patent rights on a process for the recovery of lithium from spodumene-bearing ores and concentrates. Texas Gulf plans to investigate further the mining properties and to initiate engineering and economic studies of the recovery process.

**One of the oldest coal companies** in Raleigh County, W. Va., has shut down. Lillybrook Coal Co. gave economic conditions as the reason for temporarily closing the Lillybrook Mine.

**Peabody Coal Co.** plans to purchase two Wisconsin docks operated by Michela Coal & Dock Co., Bessemer, Mich. The docks—one at Washburn, on Lake Superior, the other at Marinette, on Lake Michigan—will provide an outlet for coal mined by Peabody in Kentucky and Illinois.

**Expiration of a contract** with the Atomic Energy Commission has resulted in a production cutback at the Foote Mineral Co. plant, Kings Mountain, N. C. According to Neil O. Johnson, manager of the plant, it is the company's hope that the cutback will be temporary. "We believe there will be a substantial growth in the civilian use of lithium ore and that our mining operations will again operate at capacity," he explained.

**Detroit Steel Corp.** has sold the Emperor Coal Co., a subsidiary with mines at Stone and Freeburn, Ky. The corporation also announced that it had entered into a long-term contract for the purchase of its requirement of high, medium and low volatile metallurgical coals. Buying coal from independent sources is expected to cut steel production costs at Detroit's Portsmouth Division.

**Revere Copper and Brass, Inc.,** has established a mining department to develop ore sources, including bauxite, and has named John Collins as general manager. He recently returned to this country from the London office of American Smelting and Refining Co., where he spent eight years supervising exploration of ore prospects in Africa.

**The 15th Annual Meeting** of the Open Pit Mining Association, Electrical Division, will be held June 18, 1959, at Rollo, Mo., in cooperation with Missouri School of Mines & Metallurgy. Master of Ceremonies will be Ed Phelps, vice president of operations, Pittsburg & Midway Coal Mining Co. Ammonium nitrate explosives for open pit blasting, and cable testing and fault detection are among the subjects to be discussed.

**North American Coal Corp.,** Cleveland, Ohio, is financing construction of a $500,000 pilot plant in the Buffalo area for the manufacture of alumina and aluminum sulphate from mine waste. Since North American first announced this research project a year ago, it has successfully completed laboratory work with Strategic Materials Corp. of Buffalo. Results from the pilot operation will determine the likelihood of a commercial plant for production of high-purity alumina. North American and Strategic Materials have jointly organized Strategic-North American, Inc., to exploit the new process.

**Operation of Paco Products Company's** new mineral processing plant near Pacolet, S. C., started April 1. The plant produces refined feldspar and silica, which will be used in the South's expanding glass and ceramic tile industry. Raw material for the operation consists of by-products from the nearby Campbell Limestone Co. quarry. About 600 tons of silica and feldspar will be separated by flotation from the waste products every 24 hours.

# NEWS and views


### Climax Recovers Tin and Tungsten

A new $2,000,000 plant at Climax Molybdenum Company's huge mine in Colorado has been installed to recover minute amounts of tungsten and tin from molybdenite ore. The new plant, designed by company engineers, is a true needle-in-the-haystack operation.

The Climax-developed process is selective enough to recover about 45 parts of tungsten mineral, and one part of tin mineral, from 600,000 parts of finely ground molybdenum ore. The plant has been engineered to process some 60,000,000 lb of ore per 24 hours.

The tiny particles of cassiterite now being recovered represent the only tin mineral being produced in the United States.

The experimental operation did not prove economically practical until 1946 when a new spiral concentrator became available. The spiral concentrator is the mainstay of the new plant. The plant itself represents an expansion of by-products recovery to keep step with the recent expansion of molybdenum mining and processing facilities at Climax.

### Sulphur Company Expands Sources of Supply

Under agreement with Shell Oil of Canada Ltd., Texas Gulf Sulphur Co., and Devon-Palmer Oils Ltd. are jointly constructing a new sour gas recovery plant at Okotoks, near Calgary, Alberta, with an annual capacity of 100,000 tons of elemental sulphur. Texas Gulf will operate the sulphur plant, which is expected to come on stream by this summer.

For 1959 Texas Gulf has thus far budgeted capital expenditures of $6,000,000 to be used chiefly for the completion of the gas processing plant at Okotoks and construction of sulphur loading facilities at Beaumont, Texas, and elsewhere to handle molten sulphur, according to its annual report. Plans have also been announced for a molten sulphur terminal at Tampa, Fla., which will handle ocean vessels designed for shipment of liquid sulphur. Shipments to Tampa will begin in August, with a converted liberty ship carrying molten sulphur from the company's loading terminal near Beaumont.

### Silverton Mine Venture Underway

United States Smelting Refining & Mining Co. has leased its Sunnyside lead-silver-zinc property in Silverton, Colo., to Marcy-Shenandoah Corp. of Durango, Colo.

In Moab, Utah, Standard Uranium announced the purchase of 50 percent of the assets of Marcy-Shenandoah for an undisclosed amount of cash, and an option for a period of 36 months to purchase the remaining 50 percent.

According to U. S. Smelting officials, the Sunnyside holdings had produced substantial tonnages of lead and zinc ores prior to 1939. The lease is for 15 years with right to renew for a further term of 25 years, and requires Marcy-Shenandoah to extend the American tunnel to the leased premises and to make a connection with this tunnel to existing mine workings. Officials said the American tunnel, now 6800 ft long, would be modernized, extended an additional 4800 ft and a raise driven 480 ft to connect with existing workings, and 4000 ft of development work done to explore favorable horizons below known ore shoots.

Marcy-Shenandoah, organized to consolidate the various mining properties in the old Silverton district, has purchased the 650 to 680-tpd mill and the mine of the old Shenandoah-Dives Mining Co., and leased other mining properties from the American Smelting & Refining Co. Consolidation of these properties in the Silverton district is a step which company officials think may mean the reopening of nonferrous metal mining in the historic San Juan County, Colo., district.

**An international drill manufacturer has carved out this test mine under one of its plants. Here new designs of rock drills and other air-powered equipment are put through their final pre-production paces. In this photo, scores of test holes drilled into hard granite walls of the test mine give it the appearance of a giant honeycomb. Miner at right tests new stoper while workman at left sharpens integral drill steel**

ALSO . . .

**The longest** single track mine tunnel in the United States has been completed at the Bingham mine of Kennecott Copper Corp. The 18-ft wide, 24-ft high tunnel that is 18,000 ft long cost $11,000,000. It was started October 30, 1956 and completed well ahead of schedule. The tunnel will not be placed into use until the bottom of the pit reaches tunnel level. Then it will connect the pit bottom with the Copperton rail yards at the mouth of Bingham Canyon. While eliminating uphill haul of ore from the bottom of the pit, the tunnel will reduce mining costs.

**"Automate or die,"** was the warning given the U. S. mining industry by C. M. Marquardt, president of Industrial Physics and Electronics, of Salt Lake City, in a recent address before the 12th Annual Mining Symposium of the University of Minnesota at Duluth, Minn. "The thought that there will be a period of lower wages with higher productivity must be scrapped as wishful thinking," Marquardt said.

"The answer seems to lie," said the Utahn whose company has made control engineering installations in many metallurgical plants and mines, "in larger operating units with more automatic control devices. If our mining industry is to survive and give us increasing amounts of raw materials at lower prices, while the grade of the material decreases in value, we don't have much choice but to turn to control engineering."

**A new mining machine,** called a "transloader," has been used at American Zinc, Lead and Smelting Company's Grandview mine in Metalline Falls, Wash., since October, with "very encouraging" results. The new machine is a speedier and more mobile model of the "Gismo" machine which was first used in the Grandview mine. Rubber-tired wheels have replaced crawler tracks.

**Wildcatting for oil and gas** in the Augusta area on the eastern slope of the Continental Divide in Montana will be started by The Anaconda Co. this spring. Anaconda has leased 100 tracts of state school lands, totaling 23,000 acres, in Montana's first state land auction of the year.

# AMC CONVENTION — DENVER

## Plans Underway for September Meeting in the Mile High City

IN anticipation of another fine Mining Congress Convention, mining men and ladies of Denver are going "all out" to arrange the most worthwhile and enjoyable mining meeting of the year. Under the leadership of Cris Dobbins of Ideal Cement Co., Chairman of the A.M.C. Western Division, and Albert E. Seep of Mine and Smelter Supply Co., vice chairman of the General Committee, real progress has been made toward finalizing convention plans.

### Top-notch Program Planned

The Program Committee, under the chairmanship of Chester H. Steele of the Anaconda Co., is hard at work setting up convention sessions for Monday, Tuesday and Wednesday, September 14, 15 and 16. State and District program chairmen plan to get together next month to complete the scheduling of convention talks on the most important subjects that are of interest to the mining industry.

The value of this meeting to operating men throughout the mining industry cannot be overstressed. Along with top executives and administrative men, the production man in the field will find the general sessions, dealing with pressing economic and legislative matters, to be interesting and stimulating—and the operating sessions are, of course, "right down his alley." The opportunity to hear authorities talk about the newest technical developments, and the chance to talk with others whose problems are similar to his own, will give many a superintendent, engineer, shift boss, or maintenance man new ideas that he can put to work when he goes back to the "old grind."

J. Price Brisoe of Clear Creek County Mining Association, chairman of the Trips Committee, has made tentative plans for convention groups to visit several of Colorado's attractions that are of particular interest to miners. The Welcoming Committee under Ben C. Essig of Denver and the Publicity Committee headed by Gerould A. Sabin of Colorado Fuel and Iron Corp. are making extensive arrangements to assure convention-goers a large measure of Western hospitality and the opportunity to take in as many of Colorado's points of interest as they desire.

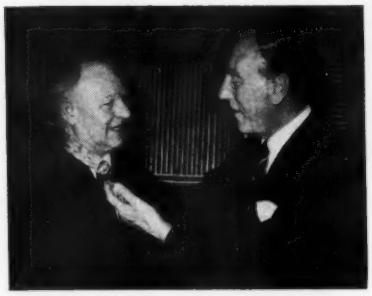
### Entertainment Tops

Entertainment for this year's meeting will be climaxed by the Annual Banquet on Wednesday evening. Informal and strictly "speechless", it will feature a fine dinner, brief introductions of honor guests, music for dancing and a top-notch floor show in the Arena of Denver's Civic Auditorium. Monday noon the Welcoming Luncheon will be held in the Lincoln room of the Shirley-Savoy Hotel, and on Monday evening the traditional Miners Jamboree will be at Elitch's Gardens, Denver's famous amusement park. A steak dinner, dancing and a fine floor show in the Trocadero Ballroom will make this a big evening.

### Special Ladies Program

A special program for the miners' ladies is being planned by the Ladies Hospitality Committee under the chairmanship of Mrs. W. T. Ahlborg. Assisting Mrs. Ahlborg in an advisory capacity are Mrs. Frank Coolbaugh of Golden, Mrs. Howard Crandell of Denver, Mrs. Cris Dobbins of Denver, Mrs. Ben C. Essig of Denver, Mrs. Albert E. Seep of Denver, and Mrs. Merrill E. Shoup of Colorado Springs. Further details on the ladies program will be announced shortly.

If you haven't already applied for reservations, now is the time to make your plans to attend. Use the AMC hotel reservation form, or write directly to AMC Housing Bureau, Denver Convention and Visitors Bureau, 225 West Colfax Ave., Denver, Colo.



Norbert F. Koepel (left), vice president of Anaconda's subsidiaries Chile Exploration Co. and Andes Copper Mining Co., was honored by the Republic of Chile. The Order of Bernardo O'Higgins in the Rank of Knight Commander was presented to him by Walter Müller, Chile's new ambassador to the United States. The medal, according to Ambassador Müller, is "given only to illustrious foreigners who have special affection for and have lent a service of value to Chile." Koepel has lived in Chile for more than 36 years and held engineering, technical and executive posts with Anaconda operations at Potrerillos, prior to coming to New York in 1955. He is a key executive in the planning of the El Salvador mine project near Potrerillos.

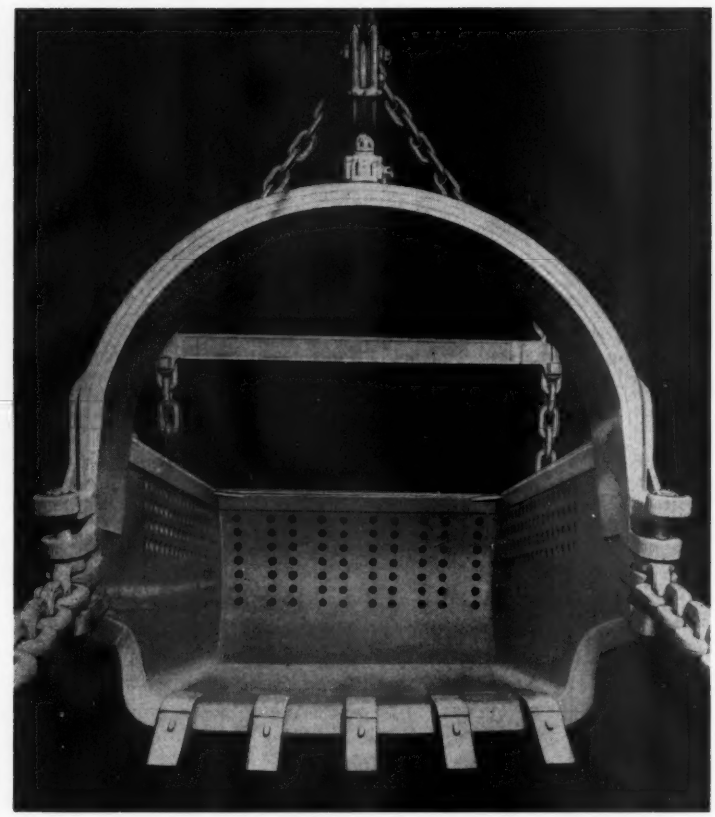
**A new fertilizer additive,** specially designed for treating perennial crops with the element molybdenum, has been developed by Climax Molybdenum Co., a division of American Metal Climax, Inc. The new product offers important economies and performance advantages over other molybdenum top dressing materials.

Molybdenum is an essential element required by plants in only tiny quantities, but it serves vital functions in the fixation and utilization of nitrogen. Treatment with this element has proved particularly effective on legume crops—alfalfa, soybeans, peanuts, clover and peas. It has enabled many farmers to improve the health of their crops and substantially increase yield.

**A 400-ton capacity mill** will be built at the Lucky Friday Silver-Lead Mines' operation east of Mullan, Idaho. All Lucky Friday ore has been trucked several miles to the Golconda custom mill for concentrating. Hecla Mining Co. of Wallace, Idaho, owns approximately 38 percent of the outstanding Lucky Friday stock.

**A new $500,000 building** for Idaho's College of Mines seems virtually assured, according to L. J. Randall, president of Hecla Mining Co. and chairman of the Idaho College of Mines' building fund. The Idaho mining industry and college alumni have raised about $230,000 of the $250,000 needed to match an equal amount which was appropriated by the State legislature.

# WANTED



## ...tough stripping situations!

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*Heavy Duty* **Mining Buckets**

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- GREATER WIDTH
- TAPERED BASKET
- ARCHED LIP
- GREATER STRENGTH

**4½ to 14 Cubic Yards With or Without Perforations**

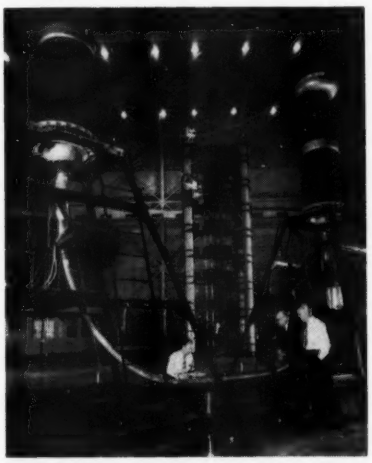
Hendrix HD Loading Buckets

**HENDRIX MANUFACTURING CO., Inc.**
**MANSFIELD, LOUISIANA**

# manufacturers forum

## Cable Research Laboratory

OPENING OF AN EXTRA-HIGH-VOLTAGE research laboratory at Hastings-on-Hudson, N. Y., has been announced by officials of Anaconda Wire & Cable Co. Composed of a unique assembly of precision equipment for research and testing of extra-high-voltage cable and accessory



designs, the new laboratory facilities cost more than $1,750,000.

Conventional designs for underground high voltage cables have practically reached their maximum power capabilities, indicating the need for improved cable-system designs. Recognizing this need, and as a contribution to the industry's progress, Anaconda Wire & Cable has constructed and placed in operation this laboratory. In addition to 60-cps a-c and impulse voltage testing, facilities are provided to cyclic-load test simultaneously at 150 percent rated voltage at operating or higher temperatures six 150-ft lengths of full-sized (2500 Mcm) commercial 345-kv cable complete with joints and terminals.

## Roof Support System

A HYDRAULICALLY-POWERED self-advancing roof support system for reportedly safer and more efficient room-and-pillar mining has been developed by a British company. Called the Dowty Canopy, the system is said to provide constant protection for the continuous mining machine and support teams. The system is released, advanced and reset by valve controls.

The Canopy system consists of two twin-section support units interconnected by a framework of longitudinal and transverse roof beams. The rear section of each support incorporates three hydraulic props, and its base houses a double-acting hydraulic jack, the rod of which is attached to the rear end of the front support section. This incorporates two hydraulic props. Valve boxes control setting and release of the props, and extension and closure of the jacks.

To advance the system, the front section of one support is released from the roof and thrust forward by extending the jack in the rear section. It is then reset, and the front section of the second support advanced in a similar manner. The rear section of the first support is next released, hauled forward by closure of the hydraulic jack, and reset to the roof, the cycle being completed by similarly advancing the rear section of the second support.

Additional information on the Dowty Canopy may be obtained from Dowty Mining Equipment Ltd., Ajax, Ontario, Canada.

## Power Pack for Switchgear Tripping, Control

PEAK D-C POWER for tripping circuit breakers is said to be assured by the AutoCal Unitized Power-Pack developed by C & D Batteries, Inc., Washington & Cherry Sts., Conshohocken, Pa. The unit combines C & D PlastiCal lead-calcium grid control batteries with the C & D AutoReg silicon charger. The battery and charger reportedly provide a dependable power package for switchgear tripping and control that requires virtually no maintenance.

A sudden demand for tripping power merely discharges the battery over a short period of time. During the time the breaker is tripped, the battery can also supply any necessary constant load current that might be required for the operation of pilot lights, holding coils, and similar requirements. Once the circuit is closed for normal operation, the charger goes to work putting energy back into the battery at a high rate until the battery again levels off at full charge.

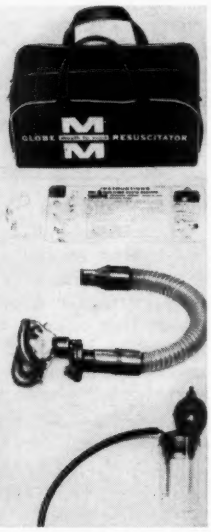
## Lightweight Diamond Core Drill

ONE MAN can operate the Winkie —a portable, lightweight diamond core drill for exploration and test hole work. The unit weighs 45 lb and is 19-in. high and 21-in. wide. It is powered by a two-cycle, air-cooled

gasoline engine producing 5½-hp at 5000 rpm. Maximum bit speed is 2000 rpm. In shallow drilling the Winkie reportedly can recover cores up to eight in. in diameter; 15/16-in. cores can be recovered down to 200 ft. The Winkie has a built-in water swivel, and a patented overhead drive principle makes runs of ten ft possible. For additional details, contact Bucyrus-Erie Co., Drill Division, Richmond, Ind.

## Rust Prevention

HANDY SPRAY CONTAINERS are said to make it simple to touch up rusted metal surfaces to prolong life and restore attractive appearance. Introduced recently by Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill., spray-on rust preventive coatings come in 16 colors and the company's transparent Clear-Sele coating. One spray coat will be sufficient for most jobs, according to the company, but where metal surfaces are badly rusted, a coat of Rust-Oleum 769 Damp-Proof Red Primer should be applied over the rust and followed by a Rust-Oleum finish coat.

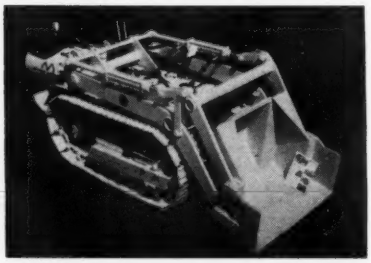



## Resuscitator

A MOUTH-TO-MASK resuscitator has been announced by Globe Industries, Inc., Dayton, Ohio. The Globe M/M Mouth-to-Mask Resuscitator is an extension of the approved mouth-to-mouth technique with all its recognized advantages over manual methods of artificial respiration. The mouth-to-mouth mask valve permits passage of air only from rescuer to the victim. The first air which the victim receives in each breathing cycle contains the full oxygen content (21 percent) of surrounding air. At no time is the patient's breath inhaled by the operator. A rebreathing system reportedly prevents hyper-ventilation and permits continuous use for long periods of time. The oronasal face mask is said to insure a tight seal, thus giving all benefits of both mouth-to-mouth and mouth-to-nose resuscitation.

## Crawler Loader

A FRONT-END, AIR-POWERED loader and dozer for underground and surface work has been introduced by Machinery Center, Inc., of Salt Lake City, Utah. The crawler loader is de-



signed to dig, bulldoze and dump at all levels, to perform under headings as low as four ft, and provides exceptional reach up to 6-ft dumping height. A 15-hp, reversible, air motor powers the machine with direct drive, three-speed transmission with travel speeds to five mph. The machine is equipped with hydraulic steering clutches and hydraulic bucket control and features simple conversion to full dozer unit. Four models are available, in bucket capacities of 3/8 cu yd, 5/8 cu yd and 1 cu yd. Air requirement is 315 cfm at 80 psig.

## Mine Power Center

A LOW-HEIGHT power center built by Westinghouse Electric Corp., Box 2278, Pittsburgh 30, Pa., is said to be the world's highest-rated sealed dry-type mine power center. It is now installed and operating in an eastern U. S. coal mine.

The 600-kva unit reduces 7200 volts to 480 volts through a delta-connected primary and a wye-connected secondary. The ASL dry-type core and coil assembly is totally enclosed in a pressure-tight nitrogen-filled compartment. The high-voltage entrance section includes a disconnecting plug for incoming cable mounted on an air compartment. Inside the air compartment is a load break disconnect switch.

A power distribution panelboard with four molded-case breakers provides built-in thermal overload and instantaneous short-circuit protection for the low-voltage section. Individual feeder ground-fault relaying protection is also provided. Each of the four feeders has a disconnect-type outlet receptacle mounted on the low-voltage dust-tight breaker and relay compartment.

## Mobile Workshop

A SELF-PROPELLED, mobile workshop, the Shop-Van is said to be designed for maximum usefulness in maintenance, repair and overhead assembly. The battery-powered unit will transport 2000 lb of tools, materials and equipment. Constructed of unitized, welded steel, the Shop-Van comes complete with telescopic work-platform, battery, bench vise, pipe vise and a large cabinet. Drill presses, bench grinders and other equipment can be mounted on the 34 by 68 in. table top. The work-shop is made by Vanguard Engineering Co., 1908 East 66th St., Cleveland 3, Ohio.

## Hydraulic Hand Pump

A MANUALLY OPERATED, two-speed hydraulic pump, which changes speed and pressure automatically, has been announced by Owatonna Tool Co., 653 No. Cedar St., Owatonna, Minn. Designed to perform common pulling jobs, the pump (No. Y19-1) provides a maximum pressure of 10,000 psi at the start of the pull. Then, after the gear, wheel or bearing is broken loose, speed increases and pressure drops automatically. Finger-tip control valve is said to assure instant release or pumping action. The 26½-lb, dual-piston pump has an oil capacity of 140 cu in. and reportedly will provide efficient operation for all of OTC's Power Twin center-hole hydraulic rams.

## Air Chucks

EIGHT NEW MODELS in its line of air chucks for off-the-road equipment have been announced by Dill Manufacturing Co., 700 East 82nd St., Cleveland 3, Ohio. Made to withstand continual abuse, these air chucks insure against costly leakage at the air lines, according to the manufacturer. In addition to three standard models, three long-handled chuck models and two clip-on models are likewise available. Also included with the introduction of these eight models are three new chuck fittings.

## Perforated Screens

RUBBER CLAD steel perforated screens are products of Hendrick Manufacturing Co., Carbondale, Pa. The company first bonds the rubber stock to steel plates under pressure. The joined sheets are then steam

(*Continued on next page*)

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cured. High quality rubber similar to the stock used for automobile tire treads is used throughout. The perforated screens are available in a wide range of thicknesses to satisfy individual screening applications.

## Electric Pump

A SUBMERSIBLE, portable electric pump, the Flygt B-150/200L has a maximum capacity of 3000 gpm and will pump to a maximum head of 220 ft. It weighs 1200 lb, can be moved by truck and light crane, and requires no installation, suction hose or priming. Other reported features of the pump are its ability to handle a high proportion of solids without clogging, and to run dry without damage—pumping starts again as soon as water flows into the sump.

A folder describing this pump may be obtained on request from Stenberg Manufacturing Corp., Hoosic Falls, N. Y.

## 100-Ton Truck


FRENCH MANUFACTURER Automobiles M. Berliet will display for the first time in the United States a Berliet T-100 truck at the International Petroleum Exposition in Tulsa, Okla., May 14–23. Designed to transport heavy oil equipment to heretofore inaccessible areas, the truck is 18 ft wide, 13 ft high, 45 ft long and is powered by a 600-hp turbodicsel engine. Its payload is up to 100 tons. In spite of its size the truck exerts tire-to-ground pressure of only 14 psi. The manufacturer claims that it requires only as much effort to drive as an American passenger car.

### ANNOUNCEMENTS

**Joy Manufacturing Co.** has announced new appointments in its Coal Machinery Division engineering staff. **A. W. Calder,** previously manager of the Continuous Miner and Loader Department, has been named director of engineering His responsibility covers engineering of Joy's continuous miners, loaders, shuttle cars, cutters, drills, and conveyors. **John Merck** has been appointed manager of engineering for products manufactured at Joy's Franklin, Pa., plants. These include miners, loaders, and shuttle cars.

Appointed chief engineers for Joy coal machinery product lines are: **C. W. Fitzgerald,** shuttle cars; **T. B. Bodimer,** loaders; **K. E. McElhattan,** continuous miners, and **C. P. Baldwin,** cutters and drills.

**Richard H. Koehler** has been appointed general sales manager of the **Le Roi Division of Westinghouse Air Brake Co.** Koehler succeeds **Jack E. Heuser** who has resigned to become an associate with the management consulting firm of Worden and Risberg of Philadelphia.

Koehler moves into this assignment from the staff of the president of Westinghouse Air Brake Co., Pittsburgh, Pa., where he has been director of advertising and publicity. He will direct the sales effort for all products of the division from headquarters at Milwaukee, Wis.

**Allis-Chalmers Manufacturing Co.** has elected a new director and a new vice president. **Joel Hunter,** president of the Crucible Steel Co. of America, Pittsburgh, Pa., was named an additional member of the board and **Beauchamp E. Smith,** general manager of the Hydraulic Division of the company with headquarters at York, Pa., was elected a vice president.

**Robert J. Russell** has been appointed executive vice president of **Hardinge Company, Inc.** He was elected vice president in charge of sales in 1953, and subsequently assumed the additional duties of corporation treasurer, which position he still retains.

Appointments of three district sales managers in **Atlas Powder Company's** Explosives Division have been announced. **Stephen M. Wilson, Jr.,** formerly manager of the Joplin, Mo., district has been named manager of the Eastern district with headquarters in Wilmington, Del. **M. A. McDuff,** who has been sales supervisor in the Houston, Texas, area of the Joplin district, was appointed manager at Joplin. **Walter R. Law,** formerly a special representative in the Chicago area, has been named manager of the Pittsburgh, Pa., district.

**Harold R. Warsmith** has been named factory manager at **Jeffrey Manufacturing Co.,** Columbus, Ohio. He was formerly general superintendent. A graduate of Ohio State University with a degree in industrial engineering, Warsmith joined the Jeffrey organization in 1936. Succeeding Warsmith as general superintendent is **John R. Simon.** Simon came to Jeffrey in 1935 and was promoted to Machine Division superintendent in June 1956.

**Harry M. Francis** has been appointed executive vice president of the **American Steel and Wire Division of U. S. Steel Corp.** In his new post Francis, who has been vice president—sales for the past 13 years, will coordinate activities of various departments of the Wire Division.

The name of the **American Metal Hose Division of American Brass Co.** has been changed to **Anaconda Metal Hose Division,** effective at once. The division's headquarters and a factory are located at Waterbury, Conn., and an additional plant is operated at Mattoon, Ill.

(*Catalogs & Bulletins next page*)

## CATALOGS & BULLETINS

REPLACEMENT PARTS FOR MINING AND ORE PROCESSING EQUIPMENT. *Columbia Steel Casting Co., Inc., 933 N.W. Johnson, Portland 9, Ore.* The four-page bulletin features replacement parts for crushers, shovels, tractors, buckets, and mining and ore processing. Columbia specializes in industrial components of Armor-Tough manganese steel and steel alloys. Typical Columbia products are illustrated and described. Ask for Bulletin No. 1063.

CONTINUOUS BORER. *Goodman Manufacturing Co., Halsted Street & 48th Place, Chicago 9, Ill.* Catalog G-124 features the Goodman Type 300 variable cutting height continuous borer for lower measures of coal.

REAR DUMP. *Advertising Dept., Euclid Division, General Motors Corp., Cleveland 17, Ohio.* The 16-page catalog describes the Model R-27 rear dump hauler for heavy construction, mines, quarries and industrial operations. Well illustrated with cutaway views of all major components and on-the-job pictures. Form 130 explains operating advantages and includes specifications.

DOZER-SCRAPER BLADE BOOKLET. *International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill.* "Here's the Inside Story on Cutting Edges" is the title of Booklet CR-177-1. It describes how operators can get longer life from cutting edges on their dozers and scrapers with exclusive IH Durablades. These blades, produced by a special heat-treating process, reportedly have a surface hardness giving two to four times longer life than untreated blades.

INTERCHANGEABLE TYPEWRITER TYPE. *Remington Rand Division of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.* A method of using a standard manual or electric or proportional-spacing typewriter for special impressions needed in the field of electronics and electricity is the subject of booklet R-8964.5. It is the first in a series designed to show how any of 18 different fields can make profitable use of interchangeable typewriter type. In the case of electricity and electronics, many complex symbols, equations, and formulae are needed, the characters for which do not exist on presently available typewriters in such convenient form. With interchangeable type heads, the typist can insert special type characters herself reportedly in a matter of seconds. The type face is snapped into place in one operation and is locked—or removed—with special magnetized tweezers.

MOTOR GRADER AND CRAWLER TRACTORS. *Construction Machinery Division, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.* Three specification sheets are available. One, MS-1325, covers the Model FORTY-FIVE motor grader. The other two, MS-1192 and MS-1284, give data about the company's HD-16 and HD-16 DC and D diesel powered crawler tractors. All three feature cutaway views with marginal notes of the models being discussed.

USES OF NICKEL ALLOY WIRE CLOTH OUTLINE. *Readers Service Section, The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.* Entitled "Which Inco Nickel Alloy Can Solve Your Wire Cloth Problem?" the booklet describes the physical advantages of wire cloth and indicates the range of weaves and sizes available for various purposes. Mechanical properties of "A" Nickel, Monel nickel-copper alloy, Inconel nickel-chromium alloy, and Incoloy iron-nickel-chromium alloy—four standard materials for wire cloth and knitted mesh—are given, along with a listing of the many products which are commonly filtered with wire cloth of those materials. Twenty-three case histories are included.

SLURRY ROCK DUST DISTRIBUTOR. *Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa.* M-S-A Model 80 slurry rock dust distributor for machine mounting is the subject of Bulletin No. 1201-6. Appropriate dimensional data lists tank capacity, discharge rate and operating time for a complete cycle (one batch) of rock dust mix. Details of a typical application and catalog numbers for unit parts are also included in the bulletin.

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